The World Is Open!

by Botond Gaál, professor
Debrecen University of Reformed Theology
ACD, 17 November, 2005

Introductory ideas

It was in veritable solitude that János Arany transformed his sublime ideas into words.[1] Thus can it be said that a wise man is only a tool in making others perceive some 'higher level of harmony'. Attila József, another renowned Hungarian poet, also sat alone by the Danube River, and in this deepest solitude he formulated words to embody the past, present and future. These outstanding poets, who were also steeped in wisdom, would take note of something which pointed to a general relationship, and then by finding a "handle" to latch onto, they would step beyond the limits of this world and point to a promising solution. By having released the fetters of this world they were able to open it up; by identifying a certain harmony in it, they blazed a path to a world-view which seeks an over-arching and comprehensive interpretation of the universe. In 1996, Edward Teller sat at this table and categorically declared, "You must understand: modern science means nothing less than that the world is open!" Having completed university-level studies in mathematics and physics and working as a theologian, I also claim that the structure of the world is of an open nature. Appealing to the premise of inclusiveness in extending this postulate, it follows that the human intellect has the same character of openness. Moreover, the congruence of the laws of the universe and of the structure of human thinking I regard as a melding into a particular harmony. This is what makes it possible for man to take ever-bolder steps forward in the pursuit of scientific knowledge. This, in fact, is the pattern repeated in all fields of science. Staying within the bounds of my own field, that of mathematics, some very telling examples which follow this pattern immediately surface. A mathematician must also recede to the deepest depths of solitude in order to notice relationships which subsequently can be equated with universal knowledge or generally accepted truths. The lessons gleaned from the historic development of mathematics have clearly justified the above. Along these lines, one may also wish to ponder the following dilemma: how does modern mathematics, through its open structure, serve the acquisition of knowledge pertaining to nature and, simultaneously, the evolution of man's ability to think? It has been emphasized thus far that mathematics has proven to be the most effective formal language in formulating descriptions of nature. From this position it is time to take a step forward with the hypothesis that this openness may prove to be beneficial not only in scientific discourse but also in other domains, such as the humanities and the practicalities of everyday life. Leaning on my schooling in theology and considering it to be a type of scientific approach to Christian thinking, I keep wondering if there is any chance of moving a step forward. If so, how should this step be taken? More exactly, the question is whether Christian thinking is open enough or not. This issue, I believe, is topical because theologians seem to have let fall into disuse the open approach

[1] Preceding this introductory lecture, József Erdei, a student of the Reformed Church College of Debrecen, gave a rendition of the poem entitled "In Solitude" by János Arany.

provided by mathematics, despite having their attention directed towards this possibility by mathematicians. The application of this open approach could have a positive effect on the development of theology – as it is outlined later in this presentation.

The closed mathematical world of the ancients

In about 300 BC, Euclid collected and gave an overview of all accumulated mathematical knowledge in his work entitled "Elements". The Greeks seem to have "discovered", "created" and "formalised" mathematics.[2] They discovered conceptual logical truths because they believed that those truths already existed in a ready state somewhere within the world of ideas. On the other hand, it is also true that the Greeks *created* mathematics because they were able to acquire new knowledge by using evidence based on the axiomatic system. In the same breath, they formalised mathematics because they believed axioms and conclusions derived from them did not necessarily have to be associated with the correlations of the natural world. Eventually they created a field of science whose axiomatic system – according to David Hilbert's twentieth century terms – was *complete, independent and free of contradictions*. This is reason enough to praise them, for the truths identified then were as true then as they are now and will continue to be so in the future. Moreover, these mathematical truths can be regarded as scientific truths which are independent of all cultures. Yet it remains a mystery why these people were unable to harmonise these truths with their knowledge of nature. There may have been something amiss with their approach. Being entirely content with their mathematical method, it would seem that they elevated it to the level of an absolute truth; being unable to imagine anything more perfect, they regarded their method as the most general and unchangeable rule in the cultivation of scientific thought. The term '*more geometrico*' (i.e. all things are to be established on the basis of the geometric model) has its origins here. Thus Euclidean geometry fixed a pattern in almost every field of scientific thought for the next two thousand years. None of Spinoza, Newton and Kant was aware that they were thinking in a closed system.

The problem of the modern age and the opening of the closed world

More than two thousand years later, modern mathematics discovered how to take a step forward. First, in the 1820s-1830s, the Hungarian János Bolyai and then the Russian Nikolai Lobatschewsky, both mathematicians, concluded that the Greek axiomatic system led to a closed system of ideas which could and should be changed in the interests of progress. János Bolyai very aptly pointed out that the renown axiom of parallels had been such an inherent part of Euclid's thinking that it and its influence had precluded the thought of stepping out of this closed world.[3] Should one have

---

[2] Compare: John D. Barrow: A fizika világképe [*The world-view of physics*]. [Physics World] Akadémiai Publishing, Budapest, 1994. 64. (in Hungarian)

[3] Compare: Mit adott a fizikának Bolyai János? [*How did János Bolyai enrich physics?*] In: Bolyai emlékkönyv [*Bolyai commemorative volume*]. Vince Publishing, Budapest 2002 (in Hungarian). 269. "An axiom has a specific and separate role in Euclid's system, since the statement it consists of emphasizes and fixes its Euclidean nature. At the same time, it represented a stable element which precluded stepping out of the

chosen to step out of this system, it was highly desirable that the ensuing change did not engender the loss of the established truths. In this respect not even Kant's ideas[4] caused Bolyai to backtrack. From a history of science perspective this might be best described as a "Promethean idea" whereby, from the "world of the gods" and its "heavenly fire", Bolyai was able to bring down to earth a small spark which forever changed the world. The idea which he formulated –which even today is revelatory– states that an *infinite* number of lines can be drawn through a point which is parallel to any given line. This is at least as "Einsteinishly" bewildering as claiming that the velocity of light is constant in any frame of reference. Yet it was from these seemingly ungraspable and extra-visual concepts that a wondrous, breathtakingly, new world came into existence. In the successive years, many capable mathematicians followed Bolyai's and Lobatschewsky's lead and the art of doing mathematics began to flourish once again. The new openness further yielded the establishment of Boole algebra and this helped attract a slew of mathematicians to this field. Then came the German mathematician, Georg Cantor, who surprised the world with the claim that the human mind was capable of distinguishing between transfinite and absolute infinities. Up until then, it was held that concepts referred to as 'absolute' were to be interpreted in terms of the ideal limit of the finite. Cantor pointed out to theologians that, although the human intellect was able to grasp the transfinite infinite, it was not able to define God Himself as Absolute. Mathematical thinking, moreover, cannot fix God in His ontological nature but can refer to His existence by exceeding its own limits. As Cantor put it, "to a certain degree the latter is beyond the comprehension of the human intellect inasmuch as it is no longer within the sphere of being mathematically determined. Transfinite infinity, on the other hand, not only utilises a wide range of possibilities in recognising God, but also offers a wealthy and ever-growing space for ideal research. … But general recognition is oft times long in coming even if such a revelation could prove to be of extreme value to theologians, it becoming an aid in arguing their case (religion)."[5] Cantor himself inspired more and more mathematicians to examine newer and newer fields. It was somewhat later that the basics of the calculation of probability were introduced, thus opening up new prospects for even more mathematicians. These mathematicians all opened up closed (or supposedly closed) fields and established a new approach for scientific thinking. The same can be said about Kurt Gödel, the twentieth century Austrian mathematician, according to whose results in logical theory the process of human thinking is open "upwards". The work of Alonzo Church and Ala Turing indicated a similar result. Mathematicians of the twentieth century not only proved the existence of the open nature of mathematical thinking, thus providing evidence of the open structure of human thinking, but also set their sights on new directions in the spirit of this openness.

Euclidean system. Removing the "barrier" opened up a path to a new, logically viable geometry and, at the same time, a new model of space."

[4] Bolyai thought the following about Kant's ideas of space: "The otherwise honourable and clever Kant insisted on his groundless and twisted theorem that space … was not self-consistent but only an idea or a frame for our visions (!)" as it was quoted by Zoltán Gábos in "Mit adott a fizikának Bolyai?" op.cit. 274.

[5] ELTE, Filozófiai Figyelő, Budapest, 1988/4. 82-83.

The discrete and continuous mathematics of our open world

When the process of resolving dilemmas emerging from axiomatisation had ground to a halt, new fields of mathematics offering challenges in research appeared on the horizon. Having already mentioned János Bolyai as the one who had "*created a new and different world out of nothing*" as far as *Scientia spatii* (i.e. the science of space) was concerned, it is now sufficient to refer to the name Riemann when investigating the subsequent period. At the age of 27, this mathematician had developed a solution for the generalization of Gaussian surface geometry in a higher dimension.[6] This achievement can also be regarded as an opening upward. Later, the application of physics was able to a significant degree generate a space-related, new mathematics. But it appears that over the past few decades the number of geometry-related problems in search of resolution has decreased.

Today, mathematical activity is traditionally divided into four categories: creating theories, proving theories, constructing algorithms and computing.[7] The last of these is more commonly referred to as computer-related science and informatics. Both pure and applied mathematics appear in each of these fields but it is not always possible to clearly separate the two. In many fields applied mathematics has come to the forefront and has proved useful in supplying better descriptions of nature, natural phenomena and other sciences –even political science, strangely enough.[8] At the same time, pure mathematics has a host of accumulated tasks waiting upon it in that the natural sciences have evolved in most rapid fashion also.

.

Because continuous mathematics cannot describe the events of the „quantum world", it was necessary to develop discrete mathematics which in itself further broadened the imagination of mathematicians. This gave rise to the advent of graph, network and game theories which represent a certain type of infinity for human cognition. The harmonization of quantum theory with the theory of relativity induced scientists to think in a new mathematical way, in this case resulting in the inception of the string and brane models. John von Neumann, a renown Hungarian mathematician, played a preeminent role in the development of twentieth century mathematics. In describing

[6] It is quite interesting to discover how the geometry developed by Riemann came into being. Riemann submitted an application for habilitation examination at Gottingen University in 1853. Traditionally, proposals for three lectures had to be submitted. Riemann had prepared only the first two because the habilitation committee generally always asked to hear the first one. But for once it happened differently. Gauss, who was also a member of the committee, wanted to hear the third lecture. This is why Riemann wrote to his younger brother that he was in difficulty. Eventually he managed to prepare the lecture and this habilitation lecture gave rise to a world-famous discovery, something which gave a lot of work for geometers following Riemann in time. Compare: János Szenthe: Relationship between hyperbolic geometry and Riemann's geometry. In: Bolyai Emlékkönyv, op.cit. 308-309., 312 (in Hungarian).

[7] Compare: András Prékopa: Gondolatok a matematikáról. (Ideas of mathematics). Confessio, Vol. XXII 1998/1.9. (in Hungarian)

[8] It was to a large part the mathematical development of the game theory that enabled the Americans to foretell – with quite high accuracy – how the Soviet politicians would react to certain issues. As yet only very few of the details are known but it became possible that one of the parties at the negotiating table could predict the answer to his question which would be forthcoming. It also made it easier to prepare for such negotiations. These interesting events took place in the second half of the twentieth century.

the mathematical bases of quantum physics[9] he came to the conclusion that there were no hidden parameters in nature. In principle, there is no limit to cognition, something which mathematicians explain to theologians in the following way: God did not resort to using hidden parameters when he created the world. In discovering all of the above, man could come to admire the openness of the intellect and of the natural world. It was this which gave renewed hope to man in the late twentieth century and it now serves up new tasks for scientists of the twenty-first century. More and more closed fields have been opened up and worlds unimaginable earlier have been made accessible for scientific research.

Opening up the closed system of theology

It came to light in the twentieth century that Christian theology could not be built on some sort of system of axioms.[10] Previous to this, many had believed that once a basic theorem was chosen as a foundational point, an entire theological system could be built upon it. This was a result of the influence exacted by *more geometrico* on the theological sciences. Kant expressed similar philosophical views and had consequently gained many followers among theologians. This was the period of the revival and spread of *theologia naturalis* which, for the most part, ran its course in the nineteenth century. Theology bore the characteristics of a closed ideological system much rather than that of intellectualism which communicated open thinking. This was in direct contrast with the basis of Christian belief which considers the Bible, as the source of the revelation of God, to be open. From this it follows that the teachings of the Bible cannot be applied as a system of axioms. Therefore, those who travel in theology should examine such teachings in terms of a scientific and mathematical perspective. It seems evident that if Christian theology truly wants to retain its theological character it must seek to apply an open way of thinking relevant to its own field in order to comprehend, explain and interpret dogmas. This is what the fathers of the church emphasized when introducing the term '*kata physin'* (i.e. everything was to be examined according to its own nature). Mathematics shows that the human intellect is infinitely open to the cognition of the created universe. At the same time, faith and religious practice can be enriched by man's effort to understand the revelations of God via the human intellect and by applying these on a daily basis. Already there have been some benevolent warnings emanating from mathematics. It is my conviction that theology must learn a lot from the open approach employed by the exact sciences. In neglecting to do this, theology will not be able to yield any tangible results. Moreover, ecumenical efforts may also produce nothing other than a hollow ring. Therefore it is recommended that all denominations apply open theological thinking in identifying those clauses which cap or close their system of beliefs and also those clauses which uphold an ideology or inflexible dogma in the name of "scientificity". As long as theology remains mired in this way, all the other sciences will have long left it in their wake. This requisite can no doubt be regarded as the '*conditio sine qua non'* of all ecumenical efforts in the twenty-first century.

[9] His famous work is entitled " Mathematische Grundlagen der Quantenmechanik.
[10] The theology of Karl Barth provides the best evidence of this.

Universities as open systems

In examining the disciplines of mathematics and theology –in themselves theoretical disciplines– the question of practical application has to be raised. In seeking the purpose of such an investigation we can formulate the question: when does an educational system or institution become open? This issue, still to be resolved, falls into the domain of higher education research. Within this domain the degree of openness at university levels may be of special interest. This can perhaps best be examined in the interrelationship between autonomy and sovereignty. Being autonomous institutions, bearing capacities for self-organization and wielding freedom, universities must ensure openness to the whole world, to science, to the arts, to philosophies and to religions within either a sovereign state or social system. As a system, in itself it also poses a mathematical problem. But it is not only a matter of mathematics, for it is also a matter of conceptual nature. Should one wish to talk about universal values and the formation of a healthy global attitude in our own surroundings, the type of approach practised at a university can be one of the most important measures, tools and trademarks in the attainment of such values. If the universities of a given country practise the open approach, it will be this same approach which will be practised at lower level institutions of education, this being due to the specificity of the system which in turn determines the development of the whole of that given society. The foremost task of universities, therefore, is to always open up systems which might be closed.

The purpose of the present conference is to make known this approach and to facilitate scientific and social development through the application of this approach.

Abstract

It can be seen in the history of mathematics that creative thinking has always laid the path which leads from closed systems to open ones. In addition to others, renown Hungarian mathematicians, János Bolyai and John von Neumann, are model figures in this respect. Mathematics today is also characterized by attempts to achieve openness, therefore it has become the most important formal language of scientific description. In return, the openness of nature urges mathematicians to discover newer and newer fields and find the adequate mathematical formulae for natural phenomena. Since the axiomatic approach in mathematics has had its impact on Christian thinking for almost two thousand years, which resulted in a certain closed approach in theology, it has become necessary to open up this field, too. It was not in the interests of mathematics in the first place, but it was due to the inherently open Biblical approach. Therefore, theology can learn much from mathematics as far as the issue of spirituality is concerned. This methodology is also the one it should adapt in its approach in university education.