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The physician: From certainty to complexity*

Abstract

There is no doubt that during the nineteenth and the first half of the twentieth century physicians were considered less as simple prescribers of medicaments and a source of ready cash, and more as the bearers of a precious patrimony of science and wisdom destined to be passed on to others and further enriched over time. Such figures are becoming extinct. Their epigones (by now considered old-fashioned) are going through a profound crisis which reflects the status of the medical world as a whole. The rapid growth of social needs seems to parallel the disappearance of the very foundations on
which this kind of doctor based his existence, but the intricate and intriguing historical regression of clinical medicine, and the disordered rhythm of its scientific revolutions, can also be identified as significant epistemiological and ethical elements.

An analysis exploring the decline of this typology of physician is not easy because the number of intelligible real facts exceeds the cognitive and organisational capacities of a single human mind. This obliges us to gather causes and connections, and bring different events together into *ad hoc* historical units. A criterion for ordering the set of events concerning the evolution of the physician figure can be the concept of complexity,
which has shaken the certainties of the logical bases of traditional medicine. In the light of this concept, the course of the development of medicine can be divided into three epochs:

- the first epoch is characterised by the episteme of the **certainty** derived from **transcendental faith;**
- the second, which began in the Baroque age, by an episteme based on the certainties deriving from **faith in scientific research;**

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- the third and present epoch is increasingly characterised by an episteme whose essence lies in **uncertainty** due to the **complexity** highlighted by technology.

The current epoch of complexity started with an awareness paradoxically revealed by the certainties of technology. The thought of Claude Bernard and the spread of technology expansion led to the realisation that natural objects - including those involved in medical disciplines - are complex rather than complicated. The concept that complexity is not a level of complication has demolished many beliefs and generated a need to extend our investigations beyond the boundaries of deterministic canons. This epistemological revolution has inevitably led to radical changes in the medical world, which therefore seems ripe for a critical review. Many of the criteria underlying the foundations of its traditional logic are changing. This gives new existential significance to some its axioms, and reduces the *a priori* nature of many of the medical propositions that depend on experience alone. In other words, there is a growing need for methodologies that are more useful for representing and explaining, what is observed rather than demonstrating its meaning and essence.

Neverthless, the scenario of the death of the "nineteenth century" physician at the end of the second millennium is not only characterised by the occurrence of scientific revolutions, but also enriched by the new organisation of medical practice. The mental torpor induced by specialisation has produced a kind of intellectual isolation which, in the case of late twentieth century medicine, has reduced the enjoyment of theoretical speculation as a means of *fertilising* pragmatic theories, and led clinicians to lose much of their aptitude for synthesis. Further, it has restricted the curiosity of physicians to go more deeply into what is known and left little space for looking over the boundaries of the unknown. Loss of certainty, ethical and technical in the face of scientific novelties, and the consequent loss of charisma have driven physicians to becoming "health entrepreneurs", a solution that is incompatible with their nature, and brushed aside the dignity and behavioural elegance characterising their position before the Second World War. But another danger threatens the figure of the physician. Because of the limitations of man, the hardware and software technologies that are rapidly extending all fields of human knowledge are transforming medical workers into mere adepts of information; in other words, we are observing the re-emergence of dangerously Taylorian mental approaches. However, although this has led to the dispersion of clinical decision making, the ferments of today are seeking to create a new culture that identifies a new kind of specialised physician (rather than specialist), who use his knowledge to generate a spirit capable of recreating new and unified strategies in clinical practice, leaving the old only the opportunity to justify their own existence.

This is a goal worthy of human enterprise.

1. Introduction

I am not absolutely sure whether the respect and deference surrounding the prototypical figure of the physician during the nineteenth and the first half of the twentieth century should be considered a reality or simply a reflection of the memory of those of us who lived the final part of that period. However, there is

no doubt that physicians were then considered less as simple prescribers of medicines and a source of ready cash, and more as the bearers of a precious patrimony of science and wisdom destined to be passed on to others and further enriched over time.

The self-control and coolness coming from a physician's experience in the mysterious area extending towards the ultimate confines of life, and his ability to give meaning to the auscultation of lung vibrations and heart murmurs, and to assess bodily health by studying the infinitely small on the basis of a smear of blood on a glass microscope slide, led him to be attributed with divine powers. Their certainty of being able to draw precise conclusions concerning the state of an organ from mysterious signs and symptoms made insecure patients see them as magicians.

The symbolic value of the small black bag, and the ritual of examination, palpation and auscultation, represented part of his healing powers; but personal respect, the weight of his role in society, and the existence of a philosophy based on the need to understand and encompass all of the dramas and emotions associated with the events of human life were all elements ensuring that his simple presence represented hope even in the face of the hardest reality.

There are many reasons for believing that the characteristics of this kind of physician were a result of the humanistic learning they acquired at school, and the scientific certainties they drew from the deterministic rules learned at University. This combined approach led to them becoming open and sensitive towards even anecdotal clinical cases, and shaped their humility in the face of the problems of life and the mystery of death. Their special charm and appeal (i.e. their charisma) was above all due to their respect for the dignity of life they learned from their masters, but it was also their behavioural elegance in relation to every act of their profession that led to the expansion of their prestige at all levels of society.

A character snapshot of the figure of the idealised physician from the nineteenth to the middle of the twentieth century can be based on the interaction of the five key components brought together in Figure 1 (Dioguardi, 1999).

Between the XIX and XX century, the scientific **certainty** of physicians was founded on the deterministic laws of the positivism of Saint Simon (1743- -1794) and Auguste Compte (1749-1827). The principle of causality, the criteria of the divisibility and measurability of matter, and the idea of stability and reversibility could all provide phenomena with intuitive explanations. The criterion of linearity, and a physics aimed at classifying all natural phenomena in terms of matter and motion according to very rigid limits of cause and effect, gave a sense of certainty that led to the physician's security.

Humanism was a term coined by Ferdinand Canning Scott Schiller (1864— -1937) to define the pragmatism that made man the measurement of things, and attributed with him with the capacity of transforming the uncreated universe

from pure disorder and the absence of purpose into a progressive and historical unity on the basis of his feelings and needs (Schiller, 1907). This, combined with the neoclassical culture of Renaissance *Umanesimo* that as early as the XV and XVI century had claimed the rights of the human person against the threats beginning to come from social and economic organisation and technical development, contributed towards making the physician and his patient the centre of attention.

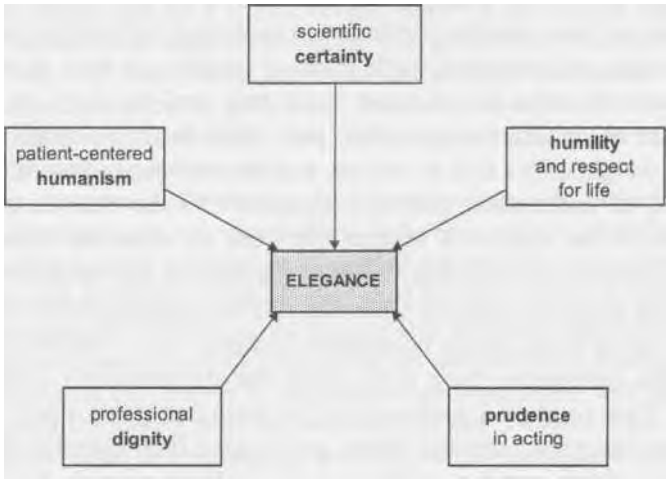

Figure 1. Schematic representation of the characteristics of the elegance distinguishing the figure of the physician from the nineteenth to the mid-twentieth century

On the basis of these foundations, the Universities taught a clinical logic aimed at establishing the complex equation of disease-physician-patient, and finding solutions directed towards the *good* of the patient. This explains why the clinicians of that time did not reject anecdotal cases. Using the aptitude for speculation learnt at school, they tried to draw significance even from individual episodes in order to integrate it with what had already been learned from personal experience. The humanism of their background made physicians accept the idea of serendipity (or chance discovery) because they considered it part of the human capacity of abstracting the constituents of an uncreated universe that could be used in practical activities.

During the course of the second millennium, these chance discoveries ("the fruit of the happy use of good luck") played an important role in improving our knowledge in many scientific areas, and often marked decisive turning points in the history of humanity. As Walter B. Cannon (1871-1945) put it (Cannon, 1982), only elect minds are favoured by chance and fortune, because they have the

aptitude of not remaining rigidly adherent to fixed ideas. On the contrary, an unenterprising intelligence finds comfort and security only in conventional and pre-ordered opinions, and is quick to reject anything that does not fall into a pre- established pattern, or which crosses the boundaries of a statistical truth. For minds that operate only in the ambit of fixed schemas, the adventures of thought are prohibited and new ideas are unacceptable. Considered in these terms, serendipitous discoveries are the fruit of mental liveliness. It is therefore no accident that, at a time when research was the fruit of the intellect and individual initiative, every such discovery contributed greatly towards increasing the charisma of the physician, because there was a reflex recognition that he was capable of taking advantage of and developing the opportunities of the new discoveries offered by destiny - and to a much greater extent than today's guidelines, protocols and consensus conferences.

For the physicians of the nineteenth and the first half of the twentieth century, **dignity** was a categorical imperative. Considering "humanity as much in your person as in the person of everyone else, and always as an end rather than a means" (Immanuel Kant, 1724—1804) was something taught at school and at home. In both places, it was taught that no man can be evaluated in terms of a price that makes him an object that can be replaced by an equivalent other, but everybody possesses a value that is not relative and has an inestimable intrinsic significance. Value and intrinsic significance are what create dignity, a property that obeys no law that has not been instituted by someone with dignity. In the period bridging the last half of the nineteenth and the first half of the twentieth century, physicians felt the dignity of their patients, and patients perceived the dignity of their physicians; as a result, the essence of every consultation consisted in the meeting of two dignities, something that has today been replaced by customer satisfaction as a result of the encounter of the suppliers and users of a service - or rather, two dissatisfactions if not two different arrogances.

The **humility** of our physician was due to the fact that the culture of the time was based on a respect for the mysteries of life, and this led to the clinical and human problems associated with disease being confronted with a regard that is not the contemplation of one's impotence but a recognition of one's ignorance. This condition makes humility a part of the virtue and balance that is capable of inhibiting the onset of presumption and its claim to be able to explain the unknowable. Even stupor in the face of the new was one of the components of a charisma arising from a humility that generates reflection.

Open-mindedness in the face of the new was united with, and completed by, the **prudence** of aphysician's acts of a physician, which was the result of a tendency towards precision, ethical rigour and behavioural clarity. Amalgamated by simplicity, reserve and consideration in relation to even extraprofessional human relationships, these properties gave our physician the traits

and ways that have currently been lost. Setting aside the category of charlatans and quacks (still far from extinct!), the physicians of those years took extreme care to avoid ridiculous or inconvenient attitudes deriving from extreme, arrogant or apodictic positions, or from affectation, ostentation or bumptiousness. In Europe, even the student spirit of university life *(goliardia,* in Italian universities, destroyed by ideologies of every kind after the Second World War), with its ability to teach one to laugh at oneself, played an important role in favouring the development of balanced self-perception. Ironic, sarcastic and desecratingly mocking, this kind of student spirit was an effective means of self-education that made it possible to develop a salutary conscience in everybody preparing to practise a profoundly human art.

Although they cannot be evaluated on the basis of precise parameters, all of these elements came together in giving a physician an ***elegance*** that could be seen even if his person had nothing that could be considered refined and his appearance was unremarkable. Elegant actions and non-arrogant behaviour contributed greatly towards creating the aura of respect surrounding the physician of that time and constructing the charisma that made him a point of reference and a person to imitate, even if his capacity to cure was less than that of his modem counterparts. Certainly, he was not perfect and contemporary newspaper reports include accounts of deviations that were as squalid and unpleasant as those of today, but what distinguished a student entering a Faculty of Medicine was the ambition of approaching moral, ethical and technical perfection (Dioguardi, 1999). A career path leading to him becoming the Director of a profitmaking hospital did not even cross his mind.

2. The twilight of the charismatic physician

Such figures are becoming extinct, and their last epigones (by now considered old-fashioned) are going through a profound crisis. In many Western countries, the crisis not only affects the individual positions of physicians but also concerns the status of the medical world as a whole. The rapid disappearance of this professional prototype was matched by the growing divergence affecting the new medicine oriented towards social needs and the increasing neglect of the very foundations on which this kind of doctor based his existence, and his need to identify other objects and facts. His fatiguing rise and brusque decline led to the birth of a myth. Given that today is an expression of yesterday, and tomorrow is also the fruit of the past (Legoff, 1993), how long does it take to establish a myth? This myth may be useful for anybody anxious to know what it will mean to be a clinical physician and medical researcher in the years immediately following the end of the twentieth century - the longest that man has ever lived through.

Myths can usually only be understood by means of an external commentary that clarifies their meanings and values, explains why they were bom and died, and identifies the environmental influences affecting their lives (Henri-Irene Marrou) (Marrou, 1954).

Given that no myth is a simple novel, a sophisticated form of science or a branch of art, there is a tendency for them to be hinged on a protagonist with a *sui generis* function that is closely intertwined with tradition, the continuity of a culture relating maturity and youth, and human feelings and emotions in relation to the past (Bronislau Kasper Malinowski, 1884-1942) (Malinowski, 1963). It is for this reason that every myth is capable of generating thoughts and stimulating meditation that can connect historical irregularities sometimes even more effectively than rigorous historiography (see endnote 1).

Michel Foucault (1926-1984) provided an interesting interpretation of the irregularities of the history of human progress (Foucault, 1956; 1969) by connecting the deviations of its course to the progress of knowledge. Deviations and corrections almost always occur in such an abrupt or contradictory manner as to produce *epistemic fractures* that divide the time of historical progress into unequal segments. He used the word *epoch* to define the segment separating one epistemic fracture and the next, with each epoch being self- represented by a type of *episteme* (episthmh = knowledge) derived from the complex of the culture, method of conceptualisation, intellectual values and ethical results making up the - epochal - fruit of the activities of human intellect and senses.

However, it is no easy task to draw epistemiological and ethical significance from the intricate and intriguing historical progression of clinical medicine or the irregularity of its scientific revolutions, not least because both are marked by the disordered rhythm of medical knowledge (see endnote 2). New medical knowledge has not always led to progress, and not all facts are intelligible, precisely because they form part of a "historical world" that is much vaster than anything that can be perceived by the senses or the intellect, and the amount of information that can be derived from intelligible real facts exceeds the cognitive and organisational capacities of the human mind.

It is for this reason that, when exploring the facts and events concerning the decline of the typology of XIX and XX century physicians, it is necessary to exclude prejudice and fable as much as possible, and concentrate on detecting the connections bringing different events together into historical units (Husserl, 1950; von Nettesheim, 1531). This means considering the debated notions that have led to the new "philosophy of nature" based on *complexity*, since this provides a focal point when dealing with the dichotomy between science (knowing) and technology (know-how) because it impregnates both science and technology.

3. The three epochs of medicine

It is up to historiographers to make an in-depth analysis of the whole set of causes which, after the end of the Second World War, led to the rapid selfextinction of the type of physician created during the course of one and a half centuries of exalting discoveries. At first glance, it may seem that this disappearance was due to the rapid loss of many of the personal characteristics discussed above; but even a superficial technical investigation intuitively suggests that at least part of the explanation lies in the intellectual dispersiveness that led to the fragmentation of medicine into a myriad of specialisations. Greater specialisation has meant that the previously used generalisations are no longer capable of providing physicians with all of the information necessary for them to make their decisions. The main reason for this epistemic change in the field of medicine is that physicians were unprepared for emergence of technical and technological advances, and are even less capable of handling the concept of complexity as a means of interpreting and exploring the natural world. The concept of complexity has shifted the focus of research from the traditional identification of causes, and the intrinsic properties of individual and discrete objects, to the study and demonstration of the inter-relationships between them, the environment and the observer. Traditional physicians have adapted to these changes in an ambiguous, vague and emotive manner that has eliminated their charisma.

On the basis of the properties subtended by the concept of complexity, which have shaken the certainties of the logical bases underlying the certainty of traditional medicine, the course of the development of medicine to the present day can be divided into three epochs:

- the first epoch began at the dawn of mankind and led to an episteme based on the **certainty** offered by **transcendental faith;**
- the second, which can be said to have had its beginning in the seventeenth century with the coming of the Baroque age, had an episteme based on the certainties deriving from **faith in scientific research;**
- the third and present epoch is increasingly characterised by an episteme whose essence lies in **uncertainty** due to the **complexity** highlighted **by** the increasing amount of knowledge furnished by technology. It can be considered as beginning with Wilhelm Conrad Roentgen (1845-1924) and Pierre Curie (1859-1906), but its roots really lie in the discoveries of William Harvey (1578-1657) and Marcello Malpighi (1628-1694).

This loss of certainty and charisma has driven physicians to become “health entrepreneurs”, a solution that is incompatible with (and has therefore brushed

aside) the behavioural dignity and elegance characterising their position before the Second World War.

3.1. Medicine based on the trascendental faith

Transcendental medicine flourished together with religion. According to Hume, religion was bom of an ancestral fear of the unknown (David Hume, 1711— -1776), and medicine as a result of the instinct that led *homo sapiens* to seek explanations for the mysteries of disease and death (Hume, 1757; 1779). All early civilisations believed that disease, cure or death were divine choices, which is why the treatment of sickness was entrusted to the witch doctors or soothsayers responsible for maintaining relationships with the gods.

Although never completely separated from religion, only Egyptian medicine was an almost exclusively practical and empirical discipline without magical or theurgical aspects. The earliest Greek medicine brought together the previous experiences of the pre-Hellenic civilisations that flourished in the Aegean and Crete. Homer describes this background of doctrine in the Iliad but, even during the most rational phase of the world of the Ancient Greeks, a sick person could still finish up in the Temple of Apollo in order to be bitten by a poisonous snake, with any improbable survival being seen as marking the end of a divine malediction. Although he did not theorise about death and disease, Aristotle (384-322 BC) considered that both were dependent on divine will.

This Aristotelian view also found its way into some forms of Medieval Christianity: disease was a punishment of God, and cure the fruit of His mercy. This was the origin of the solemn processions used to invoke the end of a plague, and also led to hospitals being conceived in the form of a transept, with an altar often surmounted by a large cross placed at the junction of the two arms. Another phenomenon paralleling these beliefs was magic, a practice that claims to dominate nature when man cannot do so. After having been clandestine for many years, it explosively emerged at the end of the Middle Ages, when it became so intimately intertwined with religion that Tommaso Campanella (1568—1639) (Campanella, 1638) actually considered the biblical deeds of Moses and the other prophets to be a form of divine magic.

Between the sixteenth and the eighteenth century, magicians, priests and physicians took on similar connotations as representatives of a defence against unknown supernatural powers; the encounter with Islam during the Crusades had brought a great deal of chemical and mathematical knowledge to the Western world, but did nothing to change the transcendental nature of its medicine.

The first signs of a change came with the Renaissance and its new way of observing Nature. This led to the emergence of great anatomists, such as Leonardo

Da Vinci (1452-1519), whose extraordinary drawings based on the dissection of corpses in the underground chambers of Milan's Ospedale Maggiore reflected his attempt to bring together human anatomy and the structure of machines, and Andrea Vesalius (1514-1564), whose *Umani Corporis Fabrica* (1543) paved the way towards descriptive anatomy (Vesalii Bruxellensis, 1543).

With the coming of the Naturalism of the Renaissance, every school of human thought adopted human nature as its foundation: man returned to occupying a central place in the universe, but the *episteme* of the epoch retained its animistic basis and continued to rely on astrology and magic. Nevertheless, Jacob Burckhardt (1818-1897) (Burckhardt, 1860) saw the Renaissance as sowing the seeds of the revolt against the *'fabric offaith* (and) *infantile ignorance"* with which the Middle Ages had bound mankind and smothered any attempt at scientific research, and beginning the process of liberation from religious prejudices. From his viewpoint in the age of Romanticism, he claimed that the medieval Judeo-Christian conception of man in the image of God laid the first roots of a scientific revolution that was to explode with Copernicus (Nikołaj Kopernik, 1473-1543) whose *De Revoluzionibus Orbium Coelestium* (see endnote 3) reproposed the heliocentric hypothesis of the solar system previously espoused by Aristarchus (310-230 BC) and the Pythagoreans.

The veracity of this hypothesis was subsequently demonstrated by Galileo Galilei (1564-1642) and generated what came to be called the Copemican revolution, a powerful prelude to the epoch of certainties based on scientific foundations.

Medicine was in the front line of these intellectual ferments.

Theophrastus Bombastus von Hohenheim, better known as Paracelsus (1493— -1541) (see endnote 4), offered the first elements of rational medicine when he published his *Eleven treatises on the origin, causes, signs and treatment of individual diseases* (1520), *Three books on surgery* (1528), *Major surgery* (1536) (Paracelso, 1573), *Paramirum* (1562-1575) and *Paragranum* (1565). In these books, he theorised the rejection of everything that was not sufficiently proved by the senses, and affirmed that every disease has a specific cause against which treatment should be directed.

The work of the great Renaissance anatomists (of whom Leonardo Da Vinci and Vesalius are the most famous) also bears the signs of an open revolt against a science and medicine that had for centuries considered God an entity that thought of everything and wished to remain inscrutable, held experimentation to be a form of investigation that had no or only very limited validity, and dismissed scientific observation as something to be looked upon with diffidence insofar as it disturbed the inscrutability of first causes. The only emotion permitted in the face of scientific results was amazement at the new.

This was the climate in which Galileo risked being burned at the stake, not so much because he had demonstrated the rotation of the Earth around the Sun,

but because he dared proposing to apply his method of *observation-experiment-demonstration* to the dogmas of the Church.

But it here needs to be underlined that the ideas of Hugo Grotius (the Latinised name of Huig de Groot, 1583-1645) concerning *the doctrine of natural law,* which were published in his most important book *De jure pads ac belli* in 1625 (Grotius, 1625), had such a strong impact on the thought of the times as to influence Isaac Newton and Galileo's view of the mathematical nature of the universe.

3.2. The medicine of Baroque certainties

The scientific revolution of Baroque medicine was based on three fundamental needs: the need for certainties arising from a more rigorous approach; the need to maintain a sense of rationalism; and the need to explore research lines that were free of both transcendental and metaphysical conceptions. It took its official form with the publication of *Delie cagioni delle febbri malignę della Sicilia negli anni 1647 e 1648* (Borelli, 1649) in 1649, now considered to be the "manifesto" of mechanicism, and the 1648 edition of *De motum animalium* (see endnote 5) by Giovanni Alfonso Borelli (1608-1679) the "breviary" of iatromechanics, or what is now called biophysics. This book introduced iatrome- chanics into the history of medicine and demolished the medicine of Hippocrates and Galen.

Borelli, who shared with Isaac Newton (1642-1727) the idea of man as a machine, also wrote that "... (one should not be afraid of) *attracting all of the criticisms of everybody who believes that it is a greater sin to disagree with the Ancients than to take lies for the truth"* (see endnote 6). In other words it is only by going against the systems imposed by scientific communities that it is possible to achieve innovation in research (Feyerabend, 1993). The use of current methodologies provides more detailed information about what is already known, but never offers insights into the unknown. This last condition typifies the state of "minority" represented by an inability to make use of one's own intellect in the absence of a guide.

It is here that the importance of William Harvey and Marcello Malpighi comes into its own: the former discovered the circulation of the blood (Harvey, 1661; 1697); the latter made use of Galileo's *occhialino* (or microscope), which Antoni van Leeuwenhoech (1632-1723) had already proved to be a powerful technological instrument for scientific research in his studies of micro-organisms invisible to the naked eye (1676), to introduce microscopic anatomy and histology (Malpighi, 1684; 1697; 1743; 1764). His intuitive vision of an organ as a complex of micro-machines may not seem totally rational in the light of modem knowledge, but the ways in which he used this means of investigation guarantee him an

important place in the history of medical methodology, and the contribution that his logic made to the birth of iatromechanics makes him a fundamental part of the history and epistemology of medicine.

Mechanicism and iatromechanics began modem science by denying the existence of any *final* order, and subsequently developed into *determinism,* whose concept of causality came to be seen as affecting all natural phenomena under the impetus of the philosophy of Thomas Hobbes (1588-1679), Pierre Gassendi (1592-1655) and Baruch Spinoza (1632-1677).

The great theoreticians of determinism were the philosopher and mathematician Jean-Antoine-Nicolas Caritat, Marquis de Codorcet (1743-1794), and the astronomer Pierre Simon Laplace (1749-1827), the same people who were to lay the basis of probabilistic theory and calculation, and who introduced statistics into the physical sciences. This was the time at which the Enlightenment burst into European thought and life, and elegance flourished as a concept analysed by Franęois Marie Arouet Voltaire (1694-1778), the most elegant intellect of the Enlightenment (Voltaire, 1764). Elegance during the Enlightenment was considered to be the result of precision and good taste. The word comes from the Latin word "electus", finds its incarnation in Jean Marie Baptiste Le Ronde d'Alembert (one of the writers of the Encyclopedia) insofar as it was his elimination of any ridiculous or arrogant attitude that led to hime being declared "electus". Jean-Franęois Marmontel (1723-1799) took d'Alembert as the prototype of the ideal elegance of the period (Marmontel, 1807).

This movement had such a profound impact on the sciences that it was still believed until not so many years ago that the keys for resolving any problem with certainty were:

a) the relationship of cause and effect, and the laws deriving from it;
b) deterministic criteria, and therefore linearity;
c) the stability obtained as a result of complicated, pre-ordained, interconnected and summable events.

The contemporary effect of the technical application of these beliefs was the spread of clocks whose movements were based on the fact that the changes in the position of each toothed wheel are transferred to the next.

Clockwork was one of the many creations of measurable movement and matter that came from the XVIII and XIX century belief in positivism, which claimed that everything scientific could be represented by means of Euclidean geometry and measured using a metric system, and had its apogee with the invention of the steam engine. Positivism also stated that there was no such thing as infinity; the universe is what is measurable and therefore finite. It was these ideas that led to the prejudice that the maturity of a discipline depends on the number of quantitative concepts it uses. It was in 1676 that Antoni van Leeuwenhoek (1632-1723) discovered the existence of micro-organisms that can

only be seen through a microscope and launched the idea of live contagion, which was demonstrated in 1835 by Agostino Bassi (1773-1856), a researcher who is almost always forgotten by historians(see endnote 7). In the medical area, Edward Jenner (1749-1823) began the era of vaccination, Louis Pasteur (1822— -1895) and Robert Koch opened up the pathway to bacteriology, and Paul Ehrlich (1843-1910) founded immunology. Rudolf Virchow (1821-1902) initiated the phase of cell pathology on the basis of the concept that every diseased cell comes from a healthy cell, and formulated the axiom *omis cellula a cellula.* It was these developments that gave rise to the charisma of the nineteenth century physician that was to survive until the mid-twentieth century.

However, by following these laws during the first half of the XX century, medicine reached uncertain and incomplete conclusions because it failed to measure itself against the revolution taking place in all of the other sciences and leading to a new way of observing nature.

3.3. The medicine of complexity

The scientific revolutions of the XX century have their roots in the concept of **complexity.** Originally used by the Stoics (Sextus Empiricus, 180-220) as a linguistic means of indicating different propositions that are in some way related by one or more connecting elements (Sextus Empiricus), the term complexity was first generalised by William Okham (1288-1349) during the last period of Scholasticism in the late Middle Ages as a means of indicating things consisting of different elements, and opposed to incomplexity (simplicity) (William Ockham, 1495). Translated into recent epistemiological terms, complexity indicates objects and events whose components are intertwined or interconnected by relationships that bring them together in a whole whose being and essence is not equal to the sum of its parts. By becoming a part of the worlds of physics, mathematics and biology, the concepts implied by the term of complexity have revolutionised the way of investigating nature in all sciences other than medicine, whose diffidence towards abstract thought and an increasingly marked tendency to privilege know- -how over knowledge led to the growing indefinition of its place among the physical and natural sciences - and also greatly reduced the charisma of physicians. This was also greatly facilitated by a social-cultural revolution.

3.3.1. The revolution induced by scientific complexity

The current epoch of complexity started with an awareness paradoxally revealed by the certainties of technology. The publication of Claude Bernard's *Introduction*

a I'etude de la medicine experimentale (Bernard, 1865) can be considered as the beginning of this epoch, which was then driven by the discoveries of Wilhelm Conrad Roentgen and Marie Skłodowska Curie (1867-1934) that opened up the era of medical imaging. In the mid-1890's, these technological discoveries led to the realisation that natural objects - and therefore the objects involved in medical disciplines - are complex rather than complicated; but it is only recently that medical science has begun to take into account that the concept of complexity demolishes many of the beliefs generated by deterministic theories and positivist concepts, and to see the need to extend its investigations beyond the boundaries of deterministic canons.

During the period in which the theories of the Enlightenment were being developed, David Hume (1711-1776) (Hume, 1739; 1740) had already begun to consider cause-effect relationships as probable rather than clearly demonstrable. He considered that a causal reaction is an idea bom from the repeated experience of the temporally and spatially contiguous nature of two entities, which leads to the first being called the cause and the second the effect; as a consequence, the observable succession is taken as being a necessity, and what is actually *post hoc* is transformed into *propter hoc.* On the basis of this reasoning, Hume came to the conclusion that we do not see causes and effects, but simply successions of events.

Hume's theory has been verified in modem times to the extent that, in a monograph published in 1958, Hans Reichenbach (1891-1953) (Reichenbach, 1958) claimed that nothing in our universe follows the laws of cause and effect. Immediately afterwards, Edward N. Lorenz (1917-) became the first of many researchers to demonstrate the truth of Reichenbach's affirmation when he described his butterfly-effect.

As a result, it began to be recognised that following the increasingly small into infinity does not lead to the emergence of general laws, but simply local rules.

In 1932, Walter B. Cannon (Cannon, 1932) concretised the theory of homeostasis: the "wisdom" that allows living bodies to return to their initial condition after alterations induced by internal and/or external stimuli. This theory is based on the notions of constant state and unstable equilibrium that underlie the concept of reversibility: the property that allows a process to go in the two directions of its course and return to its original state after it has been affected by discrete stimuli. But the concept of homeostasis as a fixed point attractor of all bodily activities aimed at maintaining the constant state of living beings is in many cases now being replaced by a concept of wave behaviour. Order, which has always been seen as the basis of the structural/functional status of living beings, is being ousted by a concept based on chaotic states, which ensure a functional flexibility that order would make rigid.

Functional/structural ideas (Luhman, 1971) began to introduce the concepts and notions of topological space, the closeness of the points in this space and the break-free deformation that transforms them into points that are not close to each other. These principles gave rise to the concept of a finite group and led to the description of structures that support the interconnected processes making up the same functional activity even if they are spatially distant from each other; the properties of these systems remain invariant even when they are submitted to radical modifications that determine the loss of their metric and projective characteristics. These topological concepts began to enter the study of nature and to influence medical science. The studies of Helge von Koch (1870-1924), Wacław Sierpiński (1882-1969), Gaston Julia (1893-1978), Luis Fray Richardson (1881-1953) (Richardson, 1922), and Benoit Mandelbrot (1924-) (Mandelbrot, 1975) demonstrated the fractal structure of natural objects. The self-similarity of their parts goes beyond the variance of the detectable by the appearance of new particulars. The painter Nachumae Miller used to say that the forms contained in a small fragment of one of his pictures are the same used in the picture as a whole because they are based on the same logic. Felix Hausdorff (1869-1942) identified the fractal dimension expressed by a non-whole number: a revolutionary act that finally dismissed the continuity of the universe as a mere measuring convenience.

General systems theory (Ludwig von Bertalanffy, 1901-1972) (Bertanlaffy, 1968) also began to make itself heard in physiology and medicine (N. Dioguardi, 1984; 1999).

The discovery that Euclidean geometry is simply a particular case useful only in the construction of manufactured objects led to the first appearance of fractal geometry in anatomy (Cross et at, 1993), physiology (Bassingthwaighte, 1994), microbiology (Obert et al., 1996), pathology and clinical practice (Losa et al., 1996; Cross, 1997; N. Dioguardi, 1992; Grizzi et al. 1999; N. Dioguardi, 1999).

What was becoming clear was the stochastic nature of the behaviour of living beings, which depends on the disorder of the *"dissipatory"* economics of the energy they internally produce in order to keep themselves far from thermodynamic equilibrium in a changeable and naturally hostile environment (Prigogine, 1987). In other words, the study of chaotic states began to enter the field of medical research. However, the concept of non-linearity (see endnote 8) characterising the systems of our universe has still not become a part of the current cultural background of physicians, and the impossibility of summing the solutions of two equations describing non-linear phenomena (naturally subject to transitions from regular to chaotic and erratic trends) in order to obtain a third is a concept that is still very distant from the interests not only of practical medicine.

The complex of all of these new ways of viewing nature has led to the re- emergence of Immanuel Kant's (1724-1804) second antimony of pure reason, which opposes the totally simple and the totally compound world. In terms of our own times, the world of manufactured objects that can be produced as a result of the certainties of man (linear, regular, unchanging, predictable and stable even when they are complicated) is opposed to the world of nature, which is nonlinear, irregular, variable, unpredictable, unstable and dominated by complexity.

The scientific revolution begun in the 1920's and 1930's, and can be identified in the crisis caused by the scientific description of happenings and phenomena in terms of models constructed using an increasingly greater number of variables and the multiplicity of their interrelationships. This made them increasingly difficult to understand using the human mind and led to the development of a new science aimed at controlling and regulating processes by identifying their "catastrophic" points - in the sense intended by Rene Thom (1923-), according to whom the term "catastrophe" indicates a sudden and unexpected change (Thom, 1972) . The essence of this revolution lies in its criticism of the logical bases of nineteenth century science (which led to the identification of the difference between "complication" and "complexity") and confutes the causality and linearity of the phenomena occurring within our universe.

3.3.2. The socio-cultural revolution

The sequence of events described above outlines the scientific scenario of the death of the "nineteenth century" physician at the end of the second millennium, but the cause was not only the occurrence of a scientific revolution for which he was unprepared, but was also due to a social upheaval.

This social change is represented by the modernist movement, something that is not sufficiently taken into account by the historiographers of medicine. This current of ideas has its origin in the economic, social and cultural ferments of the XVIII, XIX and XX centuries - sources of well-being that led to the explosion of technical and technological progress in Western Europe and North America. This movement is closely interwoven with the processes of secularisation *(seculum* as against *ceternum)* which began with the transfer of ecclesiastical goods to lay hands decided by the signing of the Treaty of Westphalia (1648) that put an end to the Thirty Years' War. Originally simply intended to be as an administrative instrument, the intertwining of secularisation with modernism gave it the value of liberating institutions throughout the world from the influence of the Church.

In 1911, Ernst Troeltsch (1865-1923) was one of the first people to express the conviction that it is necessary to eliminate every tie between God and the

world (Troeltsch, 1911). However, it was Friedrich Gogarten (1887-1967) who highlighted the epistemiological fracture interrupting the systems of conceptualisation and set of values constituting the episteme expressing the epoch of a transcendetally-based theological epoch by indicating the more rationalist episteme specific to the modern society of today (Gogarten, 1972). This dichotomy, identified by Ferdinand Tonnies (1855-1936) (Tonnies, 1887) as early as 1889, was developed by Alfred Weber (1868-1958) and became the subject of detailed studies by his brother Max Weber (1864-1920) (whose final conclusions are contained in *Economics and Society.* Weber, 1922; 1925) and by Robert Nisbet (1857-1942) in *The Sociological Tradition*, published posthumously in 1966 (Nisbet, 1967).

The theory of modernisation bom from these studies places civilisation as something between the functional/useful and culture, considering it an expression of the liberation of the spirit from substance. This movement played a decisive role in the disappearance of the physician figure as he was seen at the beginning of the XX century because it undermined the transcendental and metaphysical principles and values making up his charisma, replacing them with the rational principles of the laws of economics and socialisation. It was a revolution that shook the entire health system and the vision of a hospital.

The drive towards the secularisation of health and hospitals in Europe was certainly boosted by the ideas of Dietrich Bonhoeffer (1906-1945) contained in the letters and notes sent to his friend Eberard Bethge (published in 1951 after having been smuggled out of the Nazi extermination camps in one of which Bonhoeffer was hanged in 1945) (Bethge, 1970), and more extensively in his other works almost all of which were published posthumously. During the 1920's and 1930's, Bonhoeffer preached a rupture between the religious past and lay present created by adult man in the magazine *Zwischen den Zeiten*, founded and edited by Friedrich Gogarten. He used the words the *death of God* to define the absence of God not only from the extermination camps, but also from the world as a whole, and claimed that this was due to the respect that God himself was beginning to nurture towards mankind as a result of its growth in intellect and understanding (see endnote 9). Having become an adult (Bonhoeffer, 1972) and aware of the lay present, man no longer needs God even in disease. Hospitals were therefore liberated from the encumbrance of the Christian religion, and their charitable conduction was replaced by an entrepreneurship based on market criteria and the religion of financial profit. The new administrative order immediately decided to strip all of the charisma from the disturbing personality of the physician and degrade his role to that of a career-based dispenser of health, thus leading to an unprecedented change in the history of medicine.

In order to achieve this objective, the figure of the physician constructed during the nineteenth century was deliberately destroyed by uprooting the

traditional and consolidated genetic bases that had always regulated the evolution of his culture. The vacuum left by his disappearance has been filled by "nonphysician" health managers who believe they can govern the stochastic systems of health using deterministic criteria, and "non-manager" physicians, who have only a low profile experience in handling what are in any case only vaguely defined behaviours and skills. These two figures are not complementary because of their ambiguity and agnosia (see endnote 10). Both are the result of a vain attempt to create a cultural amalgam on the basis of principles typical of a mentality that is incapable of realising that the "homogenisation of different cultures and the destruction of history are the forces determining social crises throughout the world" (Senge, 1988)

Patients (a term deriving from the Latin word *patior* meaning "I suffer") have been transformed into clients to be offered a service, and all of the criteria of industrial marketing are applied in order to attract them. In this way, the prototype of a physician as a lay confessor has become a prevalently economic figure and therefore lost the dignity and elegance underlying the charisma that distinguished him from the members of other professions.

On the basis of what has been said above, it seems inevitable that the radical changes occurring in the medical world are ripe for a critical review that will establish new criteria for validating the foundations of its logic, give greater existential significance to some of its fundamental axioms, and reduce the *a priori* nature of many of its propositions based on experience alone. It is beginning to make use of non-linear approaches capable of allowing it to confront the problems it has to face without contradictions or antinomies; and it is also looking for solutions that are currently unavailable because of the impossibility of separately analysing parts that are more intimately intertwined and interrelated than in a simple mix. These objects and dynamics are characterized by a set of variable degrees of complexity that determine their cognitive "inertia" (Kelly, 1988) and the "limited controllability" of their pragmatic application.

The medical world has already started to use the rigorous symbolic language of traditional mathematics to describe some of the phenomena of the human body; but their linear characteristics make them more useful for representing and explaining, rather than demonstrating the meaning and essence of what is observed.

I contest the claim of anyone who is convinced that the art and science of medicine has purely operative needs, and that pure thinking is mere philosophy. This is not the first time that such an accusation has been made against a physician who desires to see an element of *neohumanism* in a discipline that is increasingly tending to distance itself from the human sciences. However, it is not necessary to be a philosopher to agree with Marrou that it is now time to combat the prejudices caused by the indolence generated by nineteenth century positivism

and accepted as an ethical norm by a type of pragmatism that has oppressed many of the needs of our difficult work as physicians: it is this poor philosophy that has developed a *forma mentis* that is only capable of dealing with a small space circumscribed by an insurmountable horizon. Awakening from the mental torpor induced by specialisation offers a means of escaping the intellectual isolation which, in the case of late twentieth century medicine, has eliminated the enjoyment of theoretical speculation as a means of *fertilising* (see endnote 11) the pragmatism of medicine, and led clinicians to lose much of their aptitude for synthesis.

4. Towards a 21st Century Perspective

The increasingly insistent demand for a return to a more "humanist" culture that underlines a renewed propensity to re-acquire the capacity for intellectual synthesis and restore his lost elegance raises a number of complex issues to which the new physicians of today must find a response. Some of these are:

- Do they still want to be considered guardians of a doctrine of integrated science whose ethical and moral values are directed towards the defence of health, a complex condition that also includes the dignity of man?
- Are they the innovators and protagonists of a medicine capable of adopting the views clarifying the hidden logos (Martin Heiddeger, 1889-1979) that have already provoked the dramatic revolution still affecting all of the sciences?
- Are they capable of replacing the mechanistic concept of complication with the perception of complexity already being used in the more sophisticated areas of scientific research, substituting the concept of the order of nature with that of *logos*, and replacing the linear mathematical notion of fractional equality with that of a non-linear vision of the world (such as fractal selfsimilarity) that more closely reflects the reality of nature?
- Are they capable of understanding the revolutionary use of the fractional dimensions falling between the 0-3 dimensions of the figures of Euclidean geometry, and the possibilities that these offer for measuring the new canonical qualities of organised biological material?
- Are they to become simple technocrats only capable of offering generic advice for improving daily life?
- Do they still believe that technology is the main parameter of change in the medical area, and fail to understand that (apart from abolishing their moments for reflection) it has really had only a superficial effect on the essence of their discipline?

- Are they aware that their work has become acephalic as a result of the impossibility of handling the enormous amount of information available, and can they explain why the new means of investigation have failed to create the conditions that would allow them to rethink their work as never before?

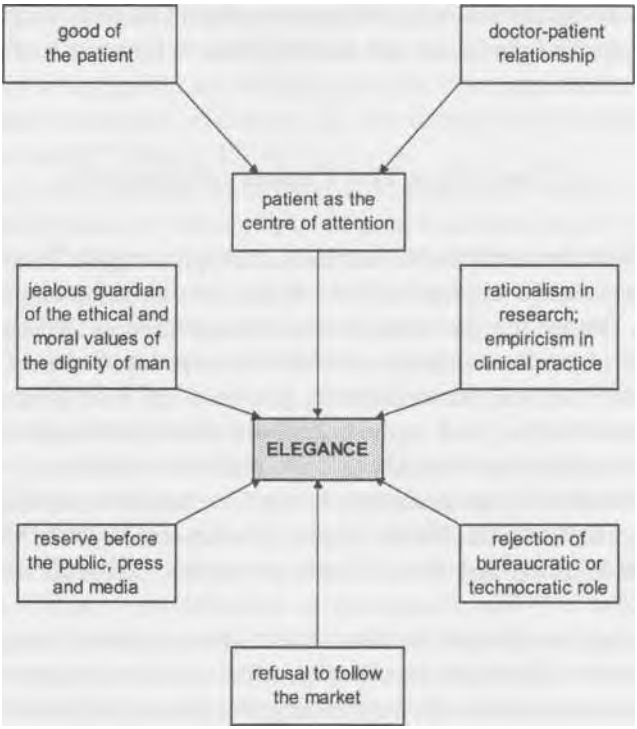

Figure 2. Schematic representation of the characteristics of the elegance distinguishing the figure of a XXI century physician (figure inspired by Figure I)

The scheme in Figure 2 summarises and comments on the main characteristics drawn from the answers to these questions, which I think may restore our lost elegance.

At the end of this philippic, what comes to mind is what the rebellions against official medicine have achieved in the past, with their powerful stimulation of thought and their effects as starting points for the discovery of new medical scenarios. At the same time, this reflection highlights the fact that today's medicine has fallen into a paranoid catatonic state induced by procedures and protocols. Computers are increasingly adopted as a glorified filing system or mechanical calculator (when they are not merely status symbols). Because of the limitations

of man, the hardware and software technologies that are rapidly extending all fields of human knowledge are transforming medical operators into mere adepts of information; in other words, we are observing the re-emergence of a dangerously Taylorian mental approach. However, although this has led to the dispersion of clinical decision making, it has also prompted the creation of a new culture that identifies a new kind of specialised physicians (rather than specialists) who use their different knowledge to generate a spirit capable of recreating new and unified strategies in clinical practice.

It is a case of bringing new areas of knowledge to traditional medicine. It is a question of returning to the practice of science in order to free ourselves from the "technological slavery" that may arise from the the excessive prevalence of computerised machinery - a perverse relationship that needs to be inverted by "enslaving technology". It is necessary to overturn a condition that is degrading the interactions between man and computers, which should be seen as cerebral prostheses capable of potentiating our mental faculties. In the words of Gianfranco Dioguardi (1937-), we are in great danger of establishing a situation in which a sort of "technological delegation" is replacing human creativity. And this is all the more deleterious insofar as it may lead to a more threatening form of "intellectual neo-Taylorism" whose consequences will be much worse than those of working on an assembly line (G.F. Dioguardi, 1999). This perversity deal has often made simple things increasingly complicated. The disastrous effect of the pharaonic use that has made the fortune of computer humbugs has been verified in industry during the 1970's.

A superficial and infantile over-evaluation of this mistake could lead to the no less serious risk of under-estimating the appropriate use of a tool that forms part of the fabric of modem working life. The field of medicine needs to confront its increasing complexity by using the computer not only as a practical aid but above all as a means of potentiating thought. The medical disciplines have to discover the essential nature of computer science.

The map of the human genome will soon be available and is likely to have what is still an unimaginable impact on medicine; but it is precisely this forthcoming event that should induce us to return to real philosophy in our unsuppressable search for significant truth. This is the only way in which medicine can once again become an authentic science and dedicate itself to discovering the new and unimagined, and it is only then that physicians will once again be able to call themselves *Homo sapiens* rather than merely *Homo abilis.*

Silicon chips connected by broad-band channels can be the neurons of a new culture for refounding medicine, with the caution that a wealth of information impoverishes attention (Herbert Simon, Nobel prizewinnner). Medicine therefore needs to:

1. Establish a global nature: abolish the incommunicability created by over-specialisation, establish a new humanism by re-reading Dante, Shakespeare and Goethe, consider the arts, philosophy and ethics, seek the interrelationships between different areas of knowledge;
2. Give new life to the Goethian idea of the unity of nature and remember that it is faced with such a sea of ignorance and the unknown that it is ridiculous to insist on acquiring more details concerning what is already known;
3. From this not so new view, generate ideas, information and relationships that do not just depend on technology;
4. Develop close networks of communications and interconnections;
5. Synthesise complex phenomena by means of original and effective formulas;
6. Study unstable equilibria;
7. Adopt technology as a means for thinking that should only be used to reduce bureaucratic difficulties;
8. Overcome the frustration induced by the growing distrust of physicians generated by journalists and columnists who write that fraud is an everyday event in hospitals and clinics - which does not mean that bad medicine should not be opposed, but that this opposition should not be used simply as a launching pad for a successful journalistic career;
9. Embrace the almost obsessive idea that it is dealing with adaptive complex systems, which does not mean studying a particular aspect of every problem and "confining general themes to social evenings" (Murray Gell-Mann, 1968) (Chiamberge, 1999).

All of this requires the refoundation of medical culture, a daunting but not impossible task. It is daunting because it will be necessary to destroy a wall of misunderstandings, power struggles and culturally conservative forces; it is not impossible, provided that it is based on a new scientific and organisational structure that is capable of advancing by itself and leaving the old to find a justification for its existence.

It is a goal worthy of human enterprise.

Endnotes

(1) The term "history" recurs among Ionic and Attic Greek authors, the major writers of the Greco-Roman age, in the late Medieval period, and in all cultured modem languages with the same ambiguity of meaning both *res gestae* (the set of individual happenings that make up a historical relation) and *historia rerum gestarum* (the science that orders, connects and directs the knowledge of occurred facts in such a way as to draw meanings from them).

One of the first people to use the word *historiographies* was Heinrich Cornelius Agrippa of Nettescheim (1486-1535) in *De incertitudine et vanitate scientarium* (1527), whereas *historiographie* recurs in a prose idyll by the English poet Nicholas Breton *(Wits Treuchmaur,* 1597). Used by Tommaso Campanella *(Philosphiae Videlicet Gramatica, Dialectica, Retorica, Poetica, Historiographia Iuxta Propria Principia,* 1638, pag. 243) to define "the art of writing history correctly", the term has retained this sense and meaning in English and French (German uses the word *Historik)-*, but in the wake of the ideas of the Neapolitan philosopher and historian Benedetto Croce (1866— -1952), the Italian word *storiografia* unites the meanings of history in general and the science of history (Benedetto Croce, *Teoria e storia della storiografia'),* Ed. Laterza, Bari, 1917 *-Filosofia e storiografia,* Ed. Laterza, Bari, 1949).

(2) If a historiographer managed to identify the succession of the segments corresponding to the phases of progress and regression that make up the trajectory of the advancement of knowledge, and if each segment were to be given a positive or negative numerical weight other than zero, he could construct a subjective time curve of his observations whose irregularity (or roughness) could be measured using its fractal dimension and which would have a certain value.

(3) Nikolaus Copernicus - *De Revolutionibus Orbium Coelestium* (first printed in Nuremberg, 1543; first edition, Warsaw, 1854). First printed shortly before his death, Copernicus hypothesised the dual motion of the earth upon its axis and around the sun on the basis of the principle that every movement in space can be explained by the movements of the observed object and the observer. It was Galileo who actually proved the hypothesis.

(4) Philuppus Aureolus Paracelsus Theophrastus Bombastus von Hohenheim (this was how he wrote his name in Latin) was bom in Zurich in 1493 and died in Salzburg in 1541. It is thought that the name Paracelsus is a reference to Aulo Cornelius Celsus who, together with Hippocrates, was one of the fathers of ancient medicine, and whose learning covered every field of knowledge. All of the work of Paracelsus is an attempt to escape from abstract scholastic doctrine.

(5) G. A. Borelli *Tractatus de motum animalium* (ex typographia Angeli Bemabó M.D.C. LXXX. Rome). The "breviary" of iatromechanics or what we now call biophysics.

(6) "Shake off the contradictions of all those who hold that it is a greater sin to dissent from the Ancients than to believe lies as if they were the truth".

(7) Having checked Bassi's results, J.L.Schdnlein (1793-1864), a young physician at Zurich University, used them as a starting point for the studies that led him to the discovery of Achorion *(Trichophyton)* as the cytological agent of tinea

favosa in 1839, four years after the publication of Bassi's discoveries *(Del mal del segno calcinaccio o muscardino. Malattia che affligge i bachi da seta.* Dalia Tipografia Orcesi. Lodi 1835). Schónlein described the discovery of Achorion in a letter to the physiologist Johannes Muller (1801-1858), which was published in Archiv fiir Anatomie, Physiologie und Wissenschaftliche Medicin in 1839 (page 82 and the figure in Table 5): ... *No doubt you have heard of Bassi's great discovery ... It seems to me to be extremely important for clarifying the genesis of diseases* ...(from Luigi Belloni, *Per la storia della Medicina,* Arnaldo Formica, Saia Bolognese, 1980).

(8) *Differences between linear and non-linear systems*

LINEAR SYSTEMS	NON-LINEAR SYSTEMS
1 React proportionally to the magnitude of inputs	1 Do not react proportionally to the magnitude of inputs
2 Do not take into account initial states in their dynamics	2 Initial conditions play a very important role in their dynamics
3 Have deterministic behaviours	3 Have stochastic behaviours
4 The solution of one of their problems can be obtained from the sum of the solutions of their sub-problems	4 The solution of one of their problems cannot be obtained from the sum of their subproblems

(9) F. Gogarten The programmatic article *Between Times* theorised the need to refound Lutheranism. *Between Times* became the title of the magazine that was the main host of dialectic theology.

(10) The set of concepts regarding what cannot be known has led to the re- emergence of what James Frederies Ferrier (1808-1864) called *agnoiology* (on page 48 of his book *Institutes of Metaphysics,* 1856) as a correlate of the term *"epistemiology"* in order to distinguish the two areas of the doctrine of human knowledge. Agnoiology defines and concerns that which is unknown (an ignorance that is also intended in the sense of a specific lack of knowledge), whereas epistemiology concerns the knowledge that leads to culture.

Herbert Spencer, the British philosopher who was a leading figure of the positivist movement, used the same type of classification to define the borders of the unknowable considered as the inconceivable (the inability to conceive something that is not known).

The unknowable is not a category because it depends on knowledge and the type of personal culture.

A novelty that reduces the unknowable (particularly if it is generated by the assumption of an ideological position) is almost always defined in terms of

rules. The inferences drawn from new rules always generate methodological changes, and transform (or at least condition) the existing standards governing physical behaviours and manual operations. It is for this reason that the rules derived from useless or artificial or preconceived novelties lead to unpropitious consequences.

(11) The term *fertilisation* was suggested by Fabio Pierotti Cei as a means of indicating something intended to activate intellectual faculties and the resourses of thought, imagination and inventiveness by bringing together destabilising proposals, enunciates, designs and projects. The concept of fertilisation is contained in Descartes' (1596-1650) "first law of nature, which states: "Every particular thing continues to remain in the same state for as long as it can, and does not change it unless it encounters other things". A series of stimulating meetings at the *Fondazione Maria Branca* in Via Broletto (Milan) led to the idea that true cultural fertilisation can only take place if we have sufficient intellectual freedom to liberate ourselves from the norms fixed by the so- called scientific communities. Willingly or otherwise, the fertilising effect not only leads to the rejection of these norms (however fundamental they are or may seem to be), but also to their violation and the adoption of their opposites. In terms of the concept of fertilisation, words such as progress, perfecting and improving can be used in their common senses of a transition to a theory that provides direct empirical proofs of its assumptions, or a unification or harmony even at the expense of any agreement with experience. In order to establish a fertilising action, it is possible to use "reason, emotion, ridicule, an attitude of serious worry or any other means that has been invented by humanity to obtain the best from its members" (P. R. Feyerbend, 1975). The concept of fertilisation is accompanied by that of *infertility,* by which is meant a refractoriness to fertilisation that leads to a state of complete satisfaction with the things of the world as they are and resists any change; the people who withdraw into this psychological state avoid the risk of exploring anything (Plotinus *Enneades* III, 2, 1. Barechier, 1924) because, according to Pierre Janet (1859-1947), this would oblige them to emerge from their oblivion and enter reality (Pierre Janet: *De I 'angoisse a I 'extase: etudes sur les croyances et les sentiments.* Chap. III. I, Soc. Pierre Janet, Paris, 1975). The concept of refractoriness recalls that of *"unknowability".*

References

J. B. Bassingthwaighte, L. S. Liebovitch, B. J. West, *Fractal Physiology*, Oxford University Press, New York, Oxford, 1994

C. Bernard, *Introduction a Fetude de la medicine experimentale*, J. B. Bailiere, Paris, 1865.

L. von BertalanfEy, *General systems theory. Essay on its foundation and development,* Braziller, New York, 1968.

E. Bethge, *Widerstand und Ergebung briefe un Aufzeichmungen aus der haft,* Keiser Verlag, Munche, 1970.

D. Bonhoeffer, *Reality and Resistance,* Abingdon, Nashville, 1972.

G. A. Borelli, *Delie cagioni delle febbri malignę della Sicilia negli anni 1647 & 1648* per Gio. Battista Roffo, 1649, Cosenza.

J. Burckhardt, *Die cultur der Renaissance in Italien. Ein Versuch,* L. Geiger ed., Basel, 1860.

T. Campanella, *Philosophie rationalis partes quinque Videlicet: Grammatica, Dialectica, Rhetorica, Poetica Historiographia Iuxta Propria Principia,* 1638, 3 pt. 1, Du Bray, Paris pag. 243.

W. B. Cannon, *Wisdom of the body,* Norton ed, London, 1932.

W. B. Cannon, *The way of an investigator. In The Physician in Literature,* The Saunder Press, Philadelphia, London, Toronto, pag. 4-11, 1982.

R. Chiamberge, *Navigatori del Sapere,* Raffaello Cortina Ed. Milan 1999, page 67.

S. S. Cross, R.D. Start, P. Silcocks., A.D. Bull, D.W.K. Cotton, J.C.V. Underwood, *Quantification of the renal arterial tree by fractal analysis.* J Pathol. 170, pp. 479- -484, 1993.

S. S. Cross, *Fractals in pathology* - J Pathol. 182, 1-8, 1997.

G. Dioguardi, *Sapere critico, sapere utile, sapere civile: quale combinazione nelprocesso di formazione del nuovo triennio? Il sapere utile.* Conference at the University of Naples, 18 May 1999.

N. Dioguardi, *La Medicina all'inizio del III millennio. Alla ricerca di una eleganza perduta.* Conference of the Societa di Scienze Lettere e Arti, Naples, Italy 26-28 March 1999, pp. 29-49, 1999.

N. Dioguardi, *Il fegato un sistema aperto,* Masson Italia, Milan, 1984.

N. Dioguardi, *Fegato a piu dimensioni,* Etas Libri, Milan, 1992.

N. Dioguardi, *Il Fegato,* In Enciclopedia del Corpo "Giovanni Treccani", (in press).

S. Empiricus, *Adversus Mathematicos,* English Translation by Richar Bett, Oxford, Clarendon Press, last ed. 1997.

P. K. Feyerabend, *Against method. Outline of an anarchistic theory of knowledge,* Verso, London, 1993.

M. Foucault, *Les mots et les choses* First edition Gallinard, 1966.

M. Foucault, *L'archeologie du savoir,* Gallimard, Paris, 1969. Id. *Folie et devaison, Histoire de la folie a Page classique,* Pion, Paris, 1961.

F. Gogarten, *Destino e speranza dell 'epoca moderna: la secolarizzazione come problema teologico,* Marcelliana, Brescia, 1972.

F. Grizzi, N. Dioguardi, P. Bossi, M. Roncalli, *Spectral Dimension To Quantify Liver Fibrosis In Needle Biopsy Specimens,* Analytical and Quantitative Cytology and Histology, 21,3; 262-266 (1999).

N. Dioguardi, F. Grizzi, *A Fractal Scoring System For Quantifying Active Collagen Synthesis During Chronic Liver Disease,* International Journal of Chaos Theory and Applications (in press).

H. Grotius, *De jure belli acpads libri tres.* First ed. Paris, Amsterdam 1625, Ed. Scientia Aalen, 1993.

W. Harvey, *De motu cordis et sanguinis in animalibus anatomica exercitatio : cui postuma hac editione accesserunt Joannis Wallaci epistolae duae quibus Harveii doctrina roboratur,* Bononiae: printed by Longhi, 1697. Id. - *Anatomica exercitatio de motu cordis et sanguignis,* Roterdami, apud Amoldus Lurs, 1661.

Theophrastus Philippus Bombastus von Hohenheim, *Chirurgia magna ab lasquino Dalhemio latinate donata,* Pema, Basel, 1573.

D. Hume, *Dialogues Concerning Natural Religions.* First edition, London, 1779. Penguin Classics, 1990.

D. Hume, *Four dissertations: I The natural history of religion,* A. Millar, London, 1757.

D. Hume, *A treatise of human nature,* First printed in London: volume I in 1739, volumes II and III in 1740. Selby Bigge, 1888.

E. Husserl, *Ideen zu einer reinen Phanomenologie und phanomenologischen Philosophic: 1. Buch: Allgemeine Einfuhrung in die reine Phanomenologie.Ed.* **Neue, auf grund der handschriftlichen Zusatze des Verf. enveit. Aufl.** *I* **hrsg. von Walter BiemeL, Haag :M. Nijhoff, 1950.**

K. Kelly, *La nuova biologia del business.* In *Ripensare U futuro. I nuovi paradigmi del Business.* Ed. Rowan Gibson. Il Sole 24 Ore, Milan, pag. 273.

J. Legoff in the Preface to *La ricerca della lingua perfetta nella cultura europea* di Umberto Eco, Ed. Laterza, Rome, Bari, 1993.

G. A. Losa, T. Nonnemacher, *Self-similarity and fractal irregularity in pathologic tissues,* Mod. Pathol, vol. 9, 174—182, 1996.

N. Luhmann, *Soziologische Aufklarung Aufsetze zur Theorie sozialer Systema.* Band 1 Opladen Westdeutscher Verlag, 1970.

B. K. Malinowski, *Sex, culture and myth,* R. Hart-Davis, London, 1963.

M. Malpighi. *(...) opera medica et anatomica varia : quibus praefationes et animadversiones addidit (..jbusque in locis emendationes instituit Faustinus Gavinellus (...)* - Editio novissima - Venetiis excudebat Andreae Poleti, 1743. Id. - *Opera Omnia,* Londini Apud R.Scott & G. Wells, 1684. Id. - *De structura glandularum conglobatarum consimiliunque partium epistoła.* Londini, Apud R. Chiswell, 1689. Id. - *Opera postuma* - Londini, Imprensis A et J. Churchill, 1697.

B. Mandelbrot, *Les objets fractals: forme, hasard et dimension,* Flammarion, Paris, 1975.

G. F. Marmontel, *Memoire de un pere pour servir a I 'instruction des ses enfants.* Paris, 1807.

H. I. Marrou, *De la connaissance historique.* Ed. Seuil, Paris, 1954.

H. C. A. von Nettesheim, *De Lncertitudine et Vanitate Scientiarum et Artium, Atque Excellentia Verba Dei,* First edition for Jean Pierre, Paris 1531.

R. Nisbet, *The social tradition,* Henemann, London, 1967.

M. Obert, P. Pfeifer, M. Semetz, *Microbial growth patterns described by fractal geometry,* J Bacteriol. vol. 172, (1990), pp. 1180-1185.

W. Ockham *Quoestiones et decisiones in IV libros sententiarum,* 1495.

I. Prigogine, G. Nicolis, *Exploring complexity. An introduction,* R. Riper GmbH & Co, Munich, 1987.

H. Reichenbach, *The philosophy of space and time,* Dover Publications Inc., New York, 1958.
L. F. Richardson, *Weather prediction by numerical process,* Cambridge University Press, Cambridge, U.K., 1922.
F. C. S. Schiller, *Studies in Humanism,* McMillan, London, 1907.
P. Senge in *Attraverso la cruna dell'ago. Ripensare al futuro. I nuovi paradigmi del business.* Editor Rowan Gibson, Ed. Il Sole 24 Ore, Milan, 1988.
R. Thom, *Stabilite structurelle et morphogenese* Benjamin, New York, 1972.
F. Tonnies, *Gemenschaft und Gezelschaft,* first edition 1887, English ed. *Comunity and Society,* translated by Charles B. Loomis, Ed. The Michigan State University Press, 1957.
E. Troeltsch, *Die bedeutung des Protestantismus fur die Entstehung der modemem welt* (first ed. 1911), Munchen ed., Berlin, third ed. 1924.
A. V. Bruxellensis, *De humani corporis fabrica libri septem.* Basileae (Basileae: ex officina Ioannis Oporini, 1543, Mense Iunio).
F. M. Voltaire, *Dizionaire philosofique portatif.* First edition, 1764.
M. Weber, *Wirtschaft und Gesellschaft,* Tubingen, 1922. Id. *Wirtschaft und Gesellschaf Zweite, Verhrherte Auflag,* edited by Marianne Weber, Tubingen, 1925.