Chapter 2
Philosophy, Science and Ethics

2.1 Philosophy: Know Yourself

According to José Ortega y Gasset "Philosophy is an activity which concerns theoretical knowledge; a theory of the universe. Even when the word "universe", which is opening panoramic vistas before us, adds to the severe word "theory" a certain life and gaiety, we must not forget that what we are going to create is not the Universe, as though we were momentarily gods, but only its theory".[1]

The Spanish economist and political scientist has pressed the point that philosophy is not the universe; it is not even that close trafficking with the universe; a process which we call "living". We simply theorize about things or contemplate them which implies maintaining ourselves outside the object of our study, keeping a chaste distance between it and ourselves. By way of a theory we are attempting to develop a system of concepts, finding elements which when set in a certain order permit us to say what "may be".

This is a challenging as well as pleasant exercise provided that the first preoccupation of the philosopher has been to know himself, capitalizing on his learning and experience. The words *know yourself* were inscribed on the temple of Delphi in ancient Greece. They were as well repeated as Leitmotif by the Seven Sages of antiquity.

The true meaning of these two words was "know yourself" as a human being. They implied a pious contrast which played an important part in ancient Greek ethics, a contrast between:

- Wisdom and moderation, and
- Presumption and arrogance (hubris).

[1] José Ortega y Gasset "*What Is Philosophy*", W.W. Norton, New York, 1960.

D.N. Chorafas, *Science and Technology*, DOI 10.1007/978-3-319-09189-1_2

In discussing the knowledge by man of himself Heraclitus, the ancient Greek philosopher noted that he had searched himself and found that character is one's *daemon*. Thus, according to one of the earlier philosophers the individual man must become the object of self-investigation. In essence, this is an existential philosophy. In the Nineteenth Century Victor Hugo put it in these terms: "The first court of justice is a man's conscience".

Nowadays many people attribute the statement *know yourself* to Socrates but in reality such saying was not his invention. It was a proverbial piece of ancient wisdom which had helped in shaping Socrates' mind. Its author, if one wants to attribute it to someone, was said to have been the god Apollo who used it to describe the tendency by true philosophers and scientists to:

- Accept their own limitations, and
- Proclaim themselves independent of external constraints.

In effect, that definition internal control balances the one we are giving for physics when we say that it is knowledge of matter. But the procedure being followed is not the same. The physicist begins by defining the problem and then its profile the outline of matter. Only after having accomplished this work is he starting his investigation aimed at understanding the object's structure. The mathematician works by way of a similar process when he defines numbers, equations and symmetries or asymmetries (Chap. 5).

Practically all the physical sciences begin by marking off for themselves part of the problem, by limiting its extent. This is a wise choice. As far as the problem's definition is concerned *know yourself* requires a holistic approach, in order to understand and appreciate its essential attributes. Then comes the process of dividing the more general problem into smaller parts, looking at each of them individually.

When looked at from the inside *know yourself* has a great deal to do with a man's conscience. When examined from the outside, it is an enormous task which involves large and significant issues as well as positive and negative concepts and acts. As already noted, Heraclitus had found the way to individual self-contemplation by stating "Man's character is his daemon", and by adding: "I searched for it for myself".

One of the important factors one tries to establish by knowing himself and by searching for his daemon is *arete*. A dictionary would suggest that this term means *virtue*, but this is only a partial response. In a more complete interpretation *arete* stands for being good at something in the sense of skill and efficiency beyond the ethical value attached to it (Sect. 2.6).

In ancient Greece *arete* stood for the kind of excellence most prized by a particular community. Among Homer's chief warrior it stood for valor. Its use by Socrates, Plato, and Aristotle expanded the world's Homeric meaning. They qualified it by the word human used as an adjective and giving it a more general sense:

- The excellence of a man as such,
- A combined sense of virtue and efficiency in living—and surprised people by suggesting that they did not know what this was.

Arete was and remains a quality that has to be developed, not just searched for. Given that its legacy is of *practical* nature, that development is feasible and search would mean discovery of the function through one's work, or *ergon*. As such *arete* depends on the proper understanding and knowledge of the job on hand.

Born about 460 BC Hippocrates provides an example of *arete* and *ergon*. He founded a medical school in his native island of Cos; a rival school also developed in Cnidos. In both places books of medicine appeared in a significant number. Fifty-eight are collected in the *Corpus Hipocraticum*. Though it is not clear how many of them go back to Hippocrates himself, or his immediate students, it is generally agreed that Cos' library was probably the nucleus of whole collection whose influence has been widespread, and not only in antiquity. It has retained its value throughout the centuries till the present day.

By working in the medical sciences, Hippocrates brought himself into contact with real life. He labored personally on the medical processes themselves, analyzing and testing them, prior to allowing himself to think any more about the world outside. By so doing, he provided as well an example of what is known as *critical philosophy*, including logic and *epistemology*—a term which stands for the theory of knowledge.

Themes belonging to critical philosophy help people become self-conscious, all the way to the point that they may begin to doubt the evidence of their senses. Another distinction being made is that of *metaphysical* philosophy, whose evolution was the aim of both Pythagoras (Sect. 2.4) and Plato. Plato aimed to combat in this way two complementary tendencies of his time:

- Intellectual skepticism, denying the possibility of knowledge on the ground that there were no lasting realties to be known, and
- Procedural anarchy, which maintained that there were no permanent and universal standards of conduct, and no higher criteria of action.

This single integrated approach sought by Plato had its reason inasmuch as philosophers do not think in a void. Their action and reaction is influenced not only by their own knowledge and experience but as well by their environment, including theories and teachings by previous philosophies. Guided by reflection they react to the external world as it presents itself to them in a given epoch.

This fundamental characteristic, the result of his own beliefs and of the time in which he lives, sees to it that two philosophers, or scientists, or technologists are bound to give different answers to specific questions. Such answers may not even be contradictory, but the way to bet is that they will be difficult to correlate.

What I have just stated is just as true of business activities, which also qualify as *ergon*. Which interests should the top echelons of an organization take into consideration as they carry out their functions? In late nineteenth and early twentieth century the accepted view was that of shareholders. The CEO's main task was to make profits for the owners, taking few other options into consideration. Slowly this shifted to include the interests of human resources: Clients and employees in top management's preoccupations.

By the 1930s, however, chiefs of major corporations began to proclaim responsibility to the whole society. Executives looking out in the longer term asserted the need to resolve conflicts not only at organizational level but as well on a much wider base so that society at large could benefit, or at least, would not be harmed by the company's activities. There are been headwinds in regard to this position which was (and continues being) constrained by the:

- Specific goals
- Past experience
- Political preferences
- Limited or finite resources
- Laws and regulations
- Embedded interests
- Utility and profits motives
- Interaction with other organizations
- Compromises constraining the domain of action
- Considerations of risk and exposure

Organizational choices are often exercised within a simplified definition of the situation which does not always include assumptions about the future, alternative courses and consequences. More weight is given to preferences of the organization, but this is not necessarily rational because those factors left aside may turn the company or the project on its head. When this happens the value system and those enacting it become the subject of questioning. New solutions are being sought, but chances are that these will be a modified version of the current alternative.

2.2 Philosophy and Science: Thales

The modern scientific ideas distinguish themselves from the classical not only through their content but also by their dynamics. Contemporary science pursues an explanation of the world which modifies quite substantially itself within one single generation, and it can only be understood if we learn and appreciate the schemas which in the past have characterized scientific thought, some of which are making a comeback.

To do so in a rational manner, we must pay attention to antiquity, not only to the ongoing knowledge revolution. It is not always appreciated that the major contribution science can do to the human species is to provide and sustain a changing view of the world. This need comes from the fact that there exist black areas of knowledge in every culture and, when left unattended they create discontinuities. The gap can be closed either through an:

- Intensive local development,
- Transborder cross-fertilization,
- Or, by bringing to mind the ancient wisdom.

Thales, the first of the seven sages of antiquity, transferred geometry to Greece from Egypt and astronomy from Babylon. He also made himself many discoveries and contributions, perhaps the most important being how to use scientific principles. Pythagoras (Sect. 2.4) who came some 35 years after Thales, transformed geometry into a free form of education, reestablishing this discipline from first principles and endeavoring to study the propositions through logic. He also developed:

- The theory of irrationals, or of propositions, and
- The construction of what was called in antiquity "cosmic solids", which today are known as polyedra.

Rather than reinventing the wheel, the ancient Greeks paid attention to cross-fertilization and to improving sciences which already existed. "In his posthumous dialog Epinomis" Plato sketches very strictly the relation of Greeks to cultures of the Orient, says B.L. Van Der Waerden, "whatever Greeks acquire from foreigners is finally turned by them into something nobler … This is also applicable to the exact sciences".[2]

In the general case, Thales and the other seven sages of antiquity were lawmakers, mathematicians, moralists and statesmen rather than scholars in today's meaning of the word. Their work had a universal character: They asked for the origin of things while at the same time they laid the foundations for the new political organization of the Greek city-states as they emerged from humanity first Middle Age (which preceded ancient Greece, contrasted to the second Middle Age which followed the fall of the Roman empire).

Thales is known as the first of the Milesian philosophers; Miletus was the larger of the very prosperous Ionian cities. He made a name for himself when in a war between Lydia and the Medes he allegedly predicted an eclipse of the sun (585 BC). He also helped Croesus, Lydia's monarch, by devising a scheme of dividing the waters of the Halys River to make an easier crossing for the Lydian army.

Among his other accomplishments, when challenged that as a philosopher he did not earn much money he invented options. Having studied to cycle of olive production, after years of poor results he predicted abundance. Following this, he bought options in the olive oil mills and the next season, when the glut came as he had calculated, he made a fortune by exercising his options.

As a natural philosopher and mathematician Thales has been an example of *arete*, gaining technical and astronomical know-how from the Chaldaeans in Babylon, but without accepting the connexion with astral religion or astrology. By turning away from mythical cosmology, and conceiving the idea of a rational theory of the *kosmos*, he looked (along with his students Anaximander and Anaximenes) for a single moving force in the natural world, the *arché*, which meant the beginning origin.

Another major contribution Thales has made to philosophy, and to science at large, was a new way of questioning which he devised. His way is now widely considered to be the beginning of scientific thinking (see also the questioning method of Socrates in Chap. 1). We should however remember that both goods

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[2] B.L. Van Der Waerden "*Science Awakening*", P. Noordhoff, Groningen, Holland, 1954.

and ideas were imported from Egypt and Babylon to Miletus a city which, as far as we know, greatly prospered during the Sixth Century BC.

Thales is also credited with the dictum: "Everything is full of gods," which Aristotle interpreted as meaning that "the soul is mingled in the whole". By extending this concept one can make the hypothesis, which characterized the thinking of some of the philosophers in antiquity, that the stuff of the world must be the stuff of life. The physical substance on which Thales was most interested has been water. Artistotle suggested that the philosopher from Miletus had probably got the notion from seeing that:

- The nutriment of all things is moist,
- The semen of all creatures has a moist nature, and
- Heat itself is generated by the moist and kept alive by it.

"With the Milesian school of natural philosophers started the history of philosophy," says Gerasomis Xenophon Santas, "and (with it) the human search for knowledge."[3] Anaximander followed on Thales' footsteps when he applied the moral human standards of his time: Right and wrong (*dike* and *adikia*), which he saw at work as the decisive forces in his own and in other cities.

Anaximander discovered the inclination of the ecliptic course of the sun's orbit, and approximately that of the planets. He did so a century before Anaxagoras who taught the motion of the planets in a direction opposite to that of what was thought to be the fixed stars. With his enlightened ideas Thales' student who had become an accomplished astronomer, was ahead of what can be thought as the normal evolution of his profession over time.

History books say that Anaximander also had a workshop in which wooden celestial spheres were manufactured, among other artifacts. Among his practical accomplishments, at about 560 he was also commissioned to place a vertical sundial, known as *quomon*, on the market place in the city of Sparta—supplied with hour lines and month lines. This was an *ergon* which, to the ancients, stood for an innovative scientific instrument.

Ancient artifacts provide documentation that, like natural philosophy, science can have a profound impact on the way people view daily life and the world. In a large number of cases, this promotes other social and economic factors, and by so doing it brings philosophy in direct contact with the *ergon* of humanity and, up to a point, with its dreams.

Since the known antiquity, a technologically promoted everyday life by necessity confronted the changes taking place in society; for example, the impact of the medical sciences on infant mortality and on longevity. Nowadays, to a long list of issues has been added the need for contraception; the financing of health care associated to old age; the quality of education; and societal changes due to women's role in the workplace.

None of subjects mentioned in the preceding paragraphs can be isolated from the universe of critical disciplines confronting society as a whole. They are part of daily

[3] Gerasimos Xenophon Santas "*Socrates*", Routledge & Kegan Paul, London, 1979.

life and more or less directly connected through causal relationships (Chap. 3). As such, they cannot be meaningfully divided by limiting lines and handled in separation of each other:

- Rearranged without regard to their effect on the rest of the constellation of outstanding issues,
- Or manipulated independently of one-another without breaking the delicate and complex web of interrelationships.

This complex world of interrelationships is philosophy's domain and it greatly contrasts to the fundamentalists belief (present in practically all denominations), which refers to adamant first principles and apply a strict logic for reaching any further conclusions. Borrowed from science, the *uncertainty principle* tells us that first principles are under steady revision—and therefore they cannot fully be seen as firm first principles.

The idea of going back to first principles and, most particularly, failing to redefine them according to up-to-date knowledge has been an unbroken theme of static scientific approaches, beliefs and efforts. We could rewrite the history of human thinking by listing the sequence of redefinitions many of which never happened, but should have taken place.

In a way, it is a natural desire to have some fixed, clear and simple cornerstone to start off from and to end at it the day. But it is the wrong approach. Therefore, an open problem for modern thinking is how society can overcome the limitations of primary human representations, and the desire for first principles. Max Born, the physicist, used to say that:

- He and his colleagues sought for firm ground and found none.
- The deeper they penetrated the more restless became the universe.

This is quite positive inasmuch as it promotes a better focused research effort aimed to enlarge the frontiers of science and therefore of knowledge. A back-to-basics approach is one that places no limit on scientific investigation of the material world and of space-time. True enough, such an approach leaves no room for an act of *creation* which is the basic common concept of most religions, but of no concern to scientific investigation.

When Pierre Simon de Laplace, the Nineteenth Century French researcher of the cosmos, astronomer and mathematician presented the results of his work on the universe to Napoleon, the emperor asked him why he did not make reference to god. Laplace answered that he did not need that hypothesis. (Centuries prior to Laplace, Protagoras had a different explanation as we will see in Sect. 2.3).

Blind adherence to first principles, no matter which these might be, is the negation of further research and development. (Remember this when we are talking about scientific research on black holes). No matter which reasons motivate the unshaken belief in first principles, this contradicts scientific investigation and it is unfit in an age of rapid change—even if many people find it difficult to shake-off past beliefs because they made their peace with them.

Great revolutions in science have arisen in two different ways: One is that of an enlightened spirit coming with a philosophical approach to attack things which are really fundamental. Through this, he makes a tremendous breakthrough based on profound philosophical insights. The other is by way of major leaps forward taking place in an empirical or experimental manner. An example is the development of theories in response to what the data we have collected is telling us.

In conclusion, change in science has a lot to do with the demolition old philosophical "certainties" that no longer seem so certain. Both ways of major changes in science have philosophical implications on existing theories leading scientists to the abandonment of old principles. For instance, the principle of predictability which had underlain classical Newtonian physics. Change requires adaptation and this, too, is a basic scientific concept.

2.3 Protagoras

The heart of ancient Greek religion was cult and ritual, not doctrine or belief. The political leaders themselves, Pericles being an example, were free of the common superstitions of their time. The philosopher Protagoras seems to have been one of the first agnostics whose words have come down to us: "Man is the measure of all things: Of those they are, that they are; and of those they are not, that they are not".

Part of the ancient's culture was their conscience that like philosophy, science sometimes produces a legacy that outstrips not only the imagination of its practitioners but also their original intentions. Art and science work in synergy by interrogating and challenging one-another's conclusions. Matter, as well as ideas, can be investigated in two ways:

- Scientific and culturally,
- In terms of their power and strength.

Power and strength are not the same said Protagoras: "I nowhere admit that the powerful are strong; only that the strong are powerful." To the sophist philosopher's opinion confidence and courage, too, were not the same. The courageous are confident; but not all the people who are confident are courageous. The other assertion made by Protagoras follows logically from those that have just been mentioned:

> About the gods, I cannot know whether they exist or not, or which form they have. For there are many barriers to knowledge, among them the obscurity of the subject and the shortness of human life.

Socrates criticized the sophists. It is however important to bring to the reader's attention the fact that Protagoras, who has been called the first political scientist and theorist of democracy, fully understood the importance of civic education. This was known in ancient Greece as *free education*, a term which has nothing to do with the meaning given to it today.

For the ancients, free education was the kind of learning which suits a free citizen with more universal ambitions in life than training for a trade. The Ionians promoted mathematics not only for the interest they had in arithmetic, geometry and astronomy but also for the sake of practical applications which they were pursuing. Not everyone, however, followed that line of thinking. Pythagoras, for example, enticed the study of mathematics as:

- An approach to external truth, and
- A way to religious contemplation (Sect. 2.4).

In his teachings Protagoras urged learning how to learn and carefully documented the central role of education in any civilized society. By suggesting that the gods are an apparent rather than true object, he pressed the point that the center of religion is not divine per se, but the human act of piety. According to Plato, Critias, the student of Socrates and master of Athens after the Peloponnesian War, used to say, that the gods are a clever invention to keep men from misbehaving when no one is watching them.

In ancient times philosophy, including natural philosophy, had kept away from concepts and differences characteristic of religious beliefs, while it promoted the (then) newly born scientific spirit. Some of the concepts which dominated that spirit are being reinvented today, but nothing changes the fact that they date back 25 centuries. Until Aristotle introduced the notion of experiments (Chap. 3) and practiced them in his laboratory, natural philosophy was (almost exclusively) the product of fertile minds.

Nothing has changed in that respect until our time. Arthur Eddington, the British physicist, believed that everything of significance about the universe could be learned by examining what went on onside one's head. (In the late 1910s Eddington led one of the two expeditions that confirmed Einstein's prediction that the sun bends starlight. In the 1930s and early 1940s Eddington created the discipline that guided the scientists hand to the first understanding of the internal constitution of stars.)

This notion of "inside a philosopher's or a scientist's head" has survived the test of time. An excellent example is the distinction made between the early deterministic laws and those newer which are indeterministic. In the latter, either likelihoods are assigned to each of possible outcomes or the assertion is made that nothing is precisely known about the initial conditions and therefore the outcome.

This finds its counterpart in present-day scientific thinking that an initial set of conditions is the best that can be hoped for in terms of our knowledge of the subject (see Heisenberg's principle of uncertainty in Chap. 1). Moreover, even indeterministic laws are being challenged by what some scientists refer to as "a second stage of indeterminism"—or, more precisely, a metalevel—in which the assignment of probabilities for the various outcomes of an event are virtually impossible to establish.

Andrei Sakharov, the Russian nuclear physicist, considered the universe as everything that exists with no boundaries and nothing outside it. According to his thinking, in it there are regions with essentially different properties though the initial state of the universe might have been (by all likelihood) homogeneous.

The entire observable structure of the universe was, according to Sakharov, the effect of *gravitational instability*, with a key role played by the instability of the processes of transformation of fields of elementary particles. A major contribution of the theory of gravitational instability is that it shows how small initial inhomogeneities grow.[4] Though this concept is directly related to cosmology it has much wider implications.

In antiquity, a speculative natural philosophy was based on observation and reason, which find themselves at the roots of every science and in every process where the search for knowledge dominates. In ancient Greece two schools confronted one another in terms of what philosophy is or should be:

- The Sophists, among them Protagoras, regarded philosophy as education and training on how to do things.
- By contrast, Socrates looked at philosophy as a process of acquiring knowledge of the nature of things.

Progress both in philosophy and in science is made through disagreements of learned people. *Black holes* provide an example. The term stands for celestial objects so dense that their gravity prevents even light from escaping. That's the prevailing hypothesis at current state of our knowledge.

Until December 1967, when John A. Wheeler, the physicist, coined the term *black hole*, these were often referred to in scientific literature as frozen stars. A collapsing star tended to close itself off from any communication with a distant observer, but its gravitational field persisted.

In 1939 Albert Einstein published a paper in the *Annals of Mathematics*: "On a Stationary System with Spherical Symmetry Consisting of Many Gravitating Masses". With it, he sought to prove that black holes were impossible. That paper used its author's own general theory of relativity and gravitation (published in 1916). The irony is that nowadays this same theory is employed by physicists to argue that black holes are not only possible but as well inevitable for many astronomical objects.

In fact, the first challenge to Einstein's thesis, seeking its reversal, did not take long until it came. A few months after his rejection of black holes, J. Robert Oppenheimer and his student Hartland S. Snyder, published a paper entitled "*On Continued Gravitational Contraction*" which used Einstein's general theory of relativity to show that black holes do exist. Further progress had to wait until the 1960s, when discoveries of quasars, pulsars and compact x-ray sources reinvigorated thinking about the fate of stars.

This is one of the better examples in the field of science that productive disagreements come out of fertile minds, and they need an uncensored freedom of expression in order to leave a footprint. Because such disagreements are the seeds of progress, like all seeds they require a fertile land otherwise they cannot blossom.

- Dogmas and censorship do not allow them to flourish,
- Experiments are necessary to back up a thesis, or its antithesis.

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[4] Andrei Sakharov "*Memoirs*", Vintage Books, New York, 1992.

While in antiquity the method of sophists and the Socratic approach to investigation and learning contrasted to one another, they also shared the belief that each event is unique in its occurrence, and this distinguishes it from all other events. It follows that every important event not only claims a place of its own but as well it does not share an objective reality with the others. Instead, it owes its uniqueness in a maze of reasons and stimuli which give rise to its own particular unfolding.

In conclusion a common ground characterizing the teaching of Protagoras and of Socrates is that the successful pursuit of any occupation demands the mastery of a particular knowledge, skill or technique. Philosophers, politicians, generals, poets and craftsmen come under this scrutiny. Socrates used to say that, to his dismay, he discovered that except craftsmen none of them knew the meaning of the words he used. (In his earlier career, prior to becoming a philosopher, Socrates himself was a craftsman.)

2.4 Philosophy and Beliefs: Pythagoras

Pythagoras, the ancient Greek philosopher, geometer and head of the Pythagorean School was born in the island of Samos, off the shores of Ionia. About 530 BC he migrated to South Italy, where he settled in the town of Croton. Pythagorean communities were to be found in various parts of ancient Greece but for political reasons they were persecuted, dispersed and scattered.

Pythagoras is being looked at today as a mathematician, particularly a geometer, but his contemporaries considered him to be a religious prophet. He was also known as a performer of miracles. He preached immortality of the soul and became the founder of the order of Pythagoreans who share initiation and purification with Oriental mystery-rites.[5]

History books say that Pythagoras was in Egypt when the country was conquered by Cambyses, the Persian king, who made him a prisoner and carried him to Babylon. There the *magi* (Zoroaster priests) introduced him to the mysteries, the theory of music and other disciplines. Music, harmony and numbers are intimately united according to the Pythagorean doctrine. Part of this harmony is geometric and Pythagoras is credited with the so-called “golden proportionality”:

$$\frac{A}{K} = \frac{L}{B}$$

where K and L are, respectively, the harmonic and arithmetic mean of A and B.

In the course of the seven years he was held in Persia, Pythagoras learned a great deal from Zarathustra’s teachings and from the Chaldeans. In the aftermath he was greatly influenced by them and the ancients considered that Pythagorean and oriental wisdom were related to the point that they pursued mathematics as a sort of religious contemplation.

[5] B.L. Van Der Waerden “*Science Awakening*”, P. Noordhoff, Groningen, 1954.

In religious terms, the core of Pythagorean teaching was a belief in the immortality of the human soul, and its progress through a series of incarnations not only in the body of a human being but as well in the bodies of other animals, which is as well a deep-rooted belief in the Hindu religion. A credo of the Pythagoreans also was that the universe, as a whole, was a living creature while that of man and the breadth of life of the infinite universe were essentially divine.

- Counted in terms of their bodies, men were many and they were mortal.
- But the essential part of each man, his soul, was not mortal, owing its immortality to a divine soul imprisoned in a mortal body.

As these references are documenting, Pythagoreans were a religious brotherhood, and it is generally accepted that the motive for their philosophy as well as its focal point was not a simple scientific curiosity. This had consequences. The founder of the school, himself, was regarded as semi-divine and a miraculous legend gathered about him. It is as well interesting to notice that the Pythagorean theories saw a revival at Roman times, particularly during the ascendance of Cicero.

The fact that the Pythagorean school found an echo in ancient Rome might have in its origin its teaching that man had as aim in life to shake off the weight of the body becoming pure spirit and rejoining the universal spirit to which he essentially belonged. This led to the supernatural explanation of the origin of words: To the mind of the Pythagoreans some power greater than human laid down the first names for things, so that:

- These names must inevitably be the right ones, and
- At the same time they are concepts of the mind.

A further consequence of this belief, according to the Pythagorean philosophy, numbers whether representing objects or conventional symbols, like words or names, were endowed with magical properties; they also had affinities of their own. In its way, this was a reflection of the fact that Pythagoras was a mathematical genius and so were some of his disciples.

The doctrine of the kinship of nature, which may be seen as the first principle of his school, was a relic of ancient belief having much in common with the notion of magic. Its second principle was the emphasis laid on form, or structure, as the proper object of study. Along with this case the idea of *limit*. In addition, as convinced moral dualists, the Pythagoreans drew up two columns under the heading of “good things” and “bad things”.

- In the “good things” column, came light and unity as well as limit.
- In the “bad column” was darkness, plurality and the unlimited.

Much of what is happening in today’s society in regard to beliefs, concepts, and events will fall in the column of “bad things”. Perhaps the most important of Pythagoras’ contributions can be found in the existence of an *inherent* order and organization. The general principle the ancient philosopher took to illustrate it was that of the imposition of limit—which, at the same time was the general Pythagorean formula.

This formula was coupled with the moral and aesthetic corollary that *limit* was good and the *unlimited* evil. By adding the notions of order, proportion and measure, the Pythagoreans laid the stress on *quantitative* differences. Each separate thing was what it was not because of its material elements, which were common to all, but due to the proportion in which those elements were arranged.

- Through this principle of proportion one class of things differed from another, and
- The Pythagorean theory argued that the law of structure was the essential issue to discover.

This structure being sought after could be expressed numerically, in terms of quantity. On the other hand, the emphasis on numbers downplayed any systematic study of logic or of grammar. The Pythagorean concept that things were numbers predated by many centuries modern account as well as some of the tools used in finance.

In conclusion, Pythagorean beliefs displayed *order* in the relations of an entity's parts. Efficient and full life depended on organization. The reason why an entity could be called a single whole was that it had fixed limits and was capable of organization. Just as the universe is a *kosmos* (an ordered whole), so each one of us is a *kosmos* in miniature. According to Pythagoras we are organisms which reproduce the structural principles of the macrocosm in a very small dimension.

2.5 Life and Death

There have been in the past thinkers who approached philosophy and science in a dynamic way and without any prejudice, but they have been a rare species. In the Seventeenth Century Baruch Spinosa (1632–1677), saw in nature the reason of his own existence (causa sua), hence of life. He looked at it as a process which was interactive with itself, and whose existence did not require an external reason or justification. There has been as well the saying that:

> Life starts as a question without an answer,
> The only evidence being that energy can sustain life.

In a way it is surprising that classical physics did not exploit Spinosa's concept to its full extent. To the contrary, scientists provided, at least publicly, very limited metaphysical ideas (physics about physics) which could help explain existing relationships between:

- Matter and space,
- Physical and logical behavior, and
- The broader perspective of life and death.

First came hydrogen, then carbon, says Dr. Heinrich Steinmann, the Swiss physicist, technologist and former vice chairman of the Union Bank of Switzerland.

To the combination of hydrogen and carbon was added oxygen, needed to transform energy inside the atom, as well as some metals like iron and copper. Still it is essentially hydrogen, carbon and sunlight which made possible the evolution of the extremely complex process we call *life*.

At the beginning philosophy and subsequently then science thrust upon themselves the mission of understanding what is life and, way down the line, finding ways for replicating its process. Physics looked into the inside of the atom while chemistry examined the outside—complementing one another in the study of the heart of matter (Chap. 3).

Death has no meaning for us, (Ο θάνατος ηδεν προς ήμάς), Epicuros (341–270 BC) once suggested, as when we exist death does not exist and as death exists we don't." Epicurus taught that pleasure in this world is the highest good—but honesty, prudence and justice are the necessary means for achieving a good life.

Twenty-three centuries separate the teaching of Epicuros from our time and some 350 years are past since the work of Spinosa. During these long periods, the world has seen and heard plenty of scientific fundamentalists who refuse to believe in metaphysics. Yet without metaphysics science is losing a great deal of itself.

Borrowing a leaf from the book of the ancient world, the philosophy of Epicuros and of the Sophists is better suited to our epoch than classical philosophy (or near-sighted science), because it deals with the solitude of man lost in the immenseness of space and time. Such a feeling of solitude is what provokes a sort of glacial terror to the mind of the majority of people. Yet it is the true refuge which ancient Greek philosophers had found.

- By nature, man is isolated from the infinite world.
- Such an isolation makes him feel *as if* he is non-existent, and
- The end result is that he fears whatever exists beyond the limited reach of his sensations.

The Epicurean philosophy addresses itself to this problem. It is in his senses that one could find the good and the bad, and a consequence of death is the absence of the senses: "The Sophists advised their listeners that they have to be accommodated to the idea that death does not mean anything because everything what is good and bad lies in sensation and perception, while with death comes their cessation".

Awareness that death does not mean anything for living creatures makes mortal life happier, because it does not suppose an infinite time after death and removes any longing for an eternal life. Nothing in life is terrible for anybody who is convinced that nothing will be terrible afterwards, in nonexistence. Stupid is he who says that he is not afraid of death because if it comes it will cause pains but only of the kind that can be expected, advises Epicurus, adding that: death which is taken to be the most dread of disasters does not interest us at all.

A research project at Ecole Polytechnique de Lausanne (EPFL) put it in this manner: "*Life is complexity*. This is demonstrated by the way a spider weaves its web or an ant colony builds its nest. This suggests that these creatures are intelligent and biologists have demonstrated that, by blindly following basic rules that have been gradually developed through natural selection, animals and colonies of animals behave in ways which are sometimes extremely complex". When complexity suddenly appears from nothingness, there are surprises of emergent behavior.[6]

The fact that the teaching of Epicurus and of the Sophists date back to antiquity should not discourage the study of the concepts which they brought forward. In fact, in the first half of the Twentieth Century, Ludwig Wittgenstein, the Austrian mathematician, added to this approach to life and death his own thinking: Death is not an event in life, he said, as we do not live to experience death:

- *If* we take eternity to mean not infinite temporal relation but *timeliness*,
- *Then*, eternal life belongs to those who life in the *present*.

It is quite curious that in the second half of the Twentieth Century science and technology twisted that concept by developing artificial intelligence and artificial life. While intelligence in a shell of bone effaces itself after death, the artificial one developed by scientists and housed in plastic or steel casting does not experience a natural death therefore it remains until it becomes extinct either by intention or by accident. This apparent permanence of an accumulated know-how and of the database supporting it poses a number of crucial philosophical questions:

- Is there intelligence without life? Is there knowledge without interaction?
- Is there thought without experience?
- Is there language without living?
- Is there mind without communications?

Far from being only theoretical diatribes, these are key issues whose roots go all the way to the origins of Homo sapiens. They address a whole range of concepts and events require basic approaches and postulates which may look as first principles. They also bring under perspective other queries which concern man as the creator of intelligent machines.

Can complex problems be solved by machines without any human intervention? How can we best approach their solution? Should the software we write be specific to the factors characterizing an immediate problem, or more general? What have we learned out of 60 years of computer usage which can make our solutions more effective? Of 30 years of intensive effort in artificial intelligence? Of the big strides forward in the communications domain and the advent of community intelligence?

2.6 Science and Ethics

"If you ask a man 'what is science'," said Konrad Lorenz, the German naturalist, "the usual answer will be physics and chemistry based on analytical mathematics. It is really a mental illness of humanity to believe that something that cannot be

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[6] EPFL, Lausanne, BioWall, an Electronic Tissue that Pulsates Like Skin. The current BioWall prototype has a surface of 2,000 molecules, each one either dead (dark) or alive (lit up). Whether a molecule survives depends only on the status of its eight immediate neighbors and on a set of rules.

defined in terms of the exact nature of science, or cannot be verified by analytical mathematics, has not real existence. Our values are emotional … (our ability) to cut off the subjective, emotional side of humans is a dirty lie".[7]

As the preceding five sections of this chapter demonstrated, philosophy and science have to do with the whole range of issues impacting man and his future, as well as his life and death, and emotions do interfere with research even we claim that science is objective. Therefore scientists bear *responsibility* for their discoveries. We should keep stressing this to ourselves and to fellow scientists. Part of the responsibility is keeping the communications channels open.

Max Planck has said that although ethics, like science, springs from national roots, neither deserves its name unless it transcends its origins. Both aim at a universal truthfulness and objective justice, equal justice for all. Planck also expressed the opinion that the value of an act lies not in the motives behind it, but in the consequences.[8]

Ethics in scientific research is as fundamental as air and water are to life. Unfortunately, says Dr. Heinrich Steinmann, there is a developing practice of falsification of experimental results. Even if it is still in its infancy, this is leading towards a polarization of science with principal reason the funding, or continuing funding, of research projects. In the end, one is uncertain about whether or not to trust the results of experiments because they might have been the subject of bias.

There is no better example on such a polarization than that of environmental research projects regarding the effects of man-made pollution. Some laboratories have indeed admitted that they have been hiding research results contradicting their theory of a pending environmental catastrophe, while other labs have deliberately biased their findings with the aim to assure continuing funding.[9]

Niels Bohr, the Danish nuclear physicist, was passionately against secrecy in science, believing that information should be shared. He thought that with no secrecy there would be no point to an arms race. The same premises are valid today about family planning and issues relating to the preservation of forests and water resources; avoidance of pollution of land, seas, and oceans; the safeguarding of the ozone layer and much more (Sect. 2.7).

For roughly 130 years, since the institution of organized research through laboratories, we have successfully used applied science to better our standard of living; in fact we have made rather significant strides in this direction. Now we must apply science in protecting and safeguarding our environment, being forceful, realistic and consistent in the goals we set out to reach.

A study scientific research effort focusing on the quality of life is necessary because it acts both as a catalyst and incubator of new ideas. Many people appreciate that research requires finding, goals, and regular reviews on deliverables—but very few care to associate science to ethics.

[7] Konrad Lorenz "*Das Jahr der Graugans*" (The Year of the Greylag Goose), Piper Verlag, Munich.

[8] J.L. Heilbron "*The Dilemmas of an Upright Man. Max Planck and the Fortunes of German Science*", Harvard University Press, Cambridge, 2000.

[9] From a personal discussion.

- Without deliverables, a scientific project is daydreaming, and
- Without ethics, research does not create a positive change to our culture.

First ethics and then deliverables assist in focusing the goals of applied science. Pollution control does not mean that the pristine waters and clean air that used to be in old times will again return on planet Earth in their original conditions. They are gone forever *even if* all further pollution stops at this very moment (though it is unrealistic to think that it will happen so fast). But without ethical values guiding the scientists' hand, it will never happen.

It is not only the fact that nobody really knows how to recreate the Earth's initial environment, because no record has been kept of it. The greater impedance is too many vested interests on continuing its destruction. There are as well too many taboos to overcome, like birth control, and too much general apathy to permit an instantaneous reversal of the current path.

Section 2.5 has explained that among living organisms extinction occurs naturally and constantly. The trouble is that human activity has most significantly increased the rate of extinction. Science is not being directed in a way to respond to the crisis with knowledge followed by action. Only recently are scientists gaining a vivid picture of the forces threatening particular species and of the damage created to the Earth's resources through over exploitation—which are much more political issues than scientific.

Ethics in science can help to overcome lots of resistances. Scientists should show the way. Changes, and most particularly the management of change, are part of the scientists' responsibilities. Scientists, of course, cannot do all alone everything that needs to be done. They cannot achieve commendable results without the appreciation by the common citizen and without support by politicians. This appreciation must focus on what is at stake. The problem is that:

- Politicians, as well as the public, have a short term horizon.
- By contrast, science works in the longer term not day to day, even if scientific work is based on a consistent and concentrated daily effort.

Those who say that there is still time to change the course of things and therefore there is no hurry are wrong. The lack of ethics to guide one's hand is one of the main reasons why so many people think that science is *amoral* (not immoral). As Sect. 2.8 brings to the reader's attention, it can eliminate friend or foe with equal ease.

Ethical behavior will not come as a matter of course. It has to be taught in the family and in school, then applied in one's daily living and in his or her profession. In their work scientists are expected to be *moral* and *virtuous*, always remembering, however, that ancient wisdom based *virtue* on a foundation of knowledge, without outlining which one of the external sources of knowledge is the most moral because morality is a man-made concept which varies through history:

- From land to land, and
- From time to time.

If virtue, as Socrates said to Protagoras, is *knowledge which cannot be taught*, then there are neither teachers nor students of virtue. But there are teachers and students of knowledge, which is not the same thing. (The Socratic method of analysis through a torrent of challenging questions, which has been explained in Chap. 1, is the best way helping people to define by themselves the virtue they spouse.)

A logical sequel is that there are *virtuous people*, but the knowledge underpinning their behavior takes time to be acquired and much of its transmission is done through osmosis. Virtuous people build themselves up in their social environment in response to their beliefs and societal goals. One of the problems in this process is that there exists a mismatch which has largely to do with the absence of limits in one's behavior, as:

- Laws are largely structural and procedural.
- They are often way behind society's evolution, and
- They are not written to promote deep ethical values.

In addition, since man became a self-conscious entity on Earth, he has mostly labored with the geopolitical rather than with the ethical environment in mind. This is true from the primitive societies, whose interest centered around housing, agriculture and then conquest of other peoples' wealth, to our time when to research on astrophysics as well as on molecular and genetic substructures became a prime domain of interest (Chap. 1).

2.7 Research on Improving the Quality of Life

While major scientific breakthroughs, such as lasers, are necessary for significant leaps forward in science and technology, there exist as well other more mundane domains where the respect of principles associated to R&D is vital. For instance, that of social responsibility associated to scientific research which has plenty to do with the quality of life. Medicine is an example which easily comes to mind; Earth science is another.

To appreciate the importance of the message conveyed by the preceding paragraph, we need to understand that much of what we learn through research in the physical sciences upsets long-held notions. It was not until the 1960s that scientists realized the Earth's crust is composed to plates. Once this became known, research in Earth science aimed to improve our understanding of how some plates are pulling apart or sliding, creating subduction zones and earthquakes and creating havoc for people living in certain areas.

Other domains, too, have benefited from pioneering projects. In matters concerning industrial production we have come to realize that we are still using wasteful practices, while we fail to exploit to the fullest extent the facilities science and technology provide. For instance, our machines do not always incorporate artificial intelligence to make them better adaptable to the working environment in which they operate. As another example, billions of gallons of gasoline are wasted due to traffic congestion in big cities, reverberating into country roads and turnpikes.

In many cases, scientists are confronted by conflicting aims, some of which are political. Raising good and protecting the environment are an example. According to the Overseas Development Institute the fastest way to address climate change would be to dramatically reduce the amount of meat people eat. By contrast, in developing countries meat consumption is considered as evidence of improvement in quality of food—and of living.

According to data published by the UN Food and Agriculture Organization, over two decades ending in 2009, China's daily per capita supply, a proxy for consumption, increased by 20 % in calories, 40 % in protein and 60 % in proteins derived from animal products. Compare this to the fact that in 2009 (latest available statistics) China's daily per capita supply of protein derived from animal products was still only equal to half the US level for that same year.[10]

A question many environmental scientists are raising is what happens if China, and the rest of the developing world gradually attain US living and eating standards. In answer to this query the synthetic beef hamburger developed in a laboratory in the Netherlands in 2013 is beginning to attract attention. But it this the answer to a better quality of life?

Far from being theoretical, quality of life poses many practical questions which will dominate political, social, economic, environment and scientific issues in the years to come. The resources of the earth and of the seas are being overexploited. Is it possible to bend this curve? Which may be the best policies? The means? Can we use scientific research to reverse trends? Can we establish research projects which reconcile conflicting aims society has thrust upon itself? The answer is not at all self-evident.

A different way of asking these questions is can we integrate scientific research with family planning in a way to serve both ecology and sociology? This will require refocusing our scientific activities in a way that fully accounts for humanity's survival in the longer term, as the Earth's resources dwindle. The major factors for such a solution are:

- Well-focused scientific research,
- Pushing the frontiers of knowledge in a quality of life direction,
- The ability of all citizen to absorb and apply the knowledge that becomes available,
- A radical restructuring of educating the young and old, to assure that this is not only possible but also effective.

In parallel, a major scientific research effort should be directed toward the cleaning of rivers, lakes, seas and oceans. The Earth's underground waterbeds must rebecome pristine. Up until a few decades ago the sea's self-generating system worked in a fairly reliable way, but with the increase in world population and corresponding amount of pollution, nearly universal industrialization, and disregard of the need to both reducing and managing the waste, more and more garbage is created and thrown to the environment. Enormous volumes of organic waste:

[10] *Financial Times*, April 11, 2014.

- Are hard to break down,
- Or are not degradable at all.

Scientific research is urgently needed in connection to waste disposal and its dumping into rivers, lakes, seas and oceans. Affluent from coastal towns carries dangerous bacteria into the mass of the Earth's water, such as salmonella, that cause typhus and feed the hepatitis virus. To make matters worse, in addition to the more or less accidental pollution there is deliberate dumping which several countries have sanctioned at the national level but it is still widely done.

Recycling is the solution but at a level more advanced than the one currently practiced. This should become a universal scientific goal. Not only the indiscriminate waste is threatening the quality of life, but there is as well wealth in recycling. Mining this so-called "urban ore", rather than extracting more of the available raw materials, is essential to preserving the available resources, protecting the environment in the longer term.

Some statistics are eye-opening. Producing a ton of paper from recycled fiber saves about 3,700 pounds of trees and 24,000 gallons of water. Melting down a ton of aluminum cans saves 8,800 pounds of bauxite and 1,000 pounds of petroleum cake. "Our cities are a reliable source of natural resources," says Greenpeace Recycling Project Coordinator Bryan Bence, "To ignore minerals is a crime against the Earth".[11]

In the United States, in a year, recyclers collected over 40 billion aluminum cans, and their amount increases year after year. To understand the economic value of recycling let's look at the following fact. When aluminum is becoming expensive, thieves are dismantling highway guard rails and street lamps; they also tear the aluminum siding off houses to collect the half-a-dollar each pound is worth.

Recycling is both economically sound and ecologically valuable. It is also sanitary, providing for a higher quality environment and therefore a healthier life. Scientists working on water resources cite plenty of examples in their lectures and research papers, documenting them by the fact that practically no rivers, lakes, seas or oceans have been spared. The Atlantic, for instance, has become the official dumping ground for radioactive waste permitted by unethical "international agreement". Statistics on the difference in pollution in the Atlantic Ocean between two trips of Kon Tiki, separated by only 15 years, suggest that during the second trip the crew confronted a polluted ocean.

This is bad news but at the same time it identifies an excellent opportunity for the exercise of scientific research characterized by ethics and responsibilities towards the environment. With longevity, intensive medicine, the rapid increase in throw-away materials and a booming natality (particularly in less developed countries) we have no option but develop very efficient processes and methods for handling the growing volumes of dangerous waste created by our society.

In conclusion, scientific investigation and its deliverables can play a leading role in the domain of quality of life, focusing on the downside of products,

[11] *Greenpeace*, Volume 14, No. 1, January/February 1989.

processes and procedures which have become mainstream. Grass does not grow just because earth is there. Grass must be encouraged to grow. In the past this was done through irrigation, crop rotation, and lot rotation. During the last 60 years, however, greater land productivity is sought by way of an intensive use of fertilizers which have severe side effects—and the same is true of pesticides.

We have to change our approach in treating our environment by developing new ethics and values all over the world. Intensive, focused scientific research and education are the ways for achieving this outcome but they will not be effective as a matter of course. They have to be given priority and this requires both sponsorship and ethics.

2.8 Why Science Is Amoral

Asked by a young admirer to be introduced into science, because science is divine since it had just saved its state of Syracuse besieged by the Romans, Archimedes pointed out that science is divine. Subsequently, he qualified his statement by adding that:

- Science has been divine *before* she helped the state, and
- She is divine independently of whether she helped the state or not.[12]

This is not a universally held opinion. Science, Dr John von Neumann, the mathematician, once suggested, is probably not an iota more divine because she helps the state or society. He then added that if one subscribes to this position one should contemplate, at the same time, a dual proposition:

- If science is not *more* divine for helping society
- May be she is not *less* divine for harming society.

"Helping" and "harming" become meaningful only in conjunction to human values and objectives, which are never stable. The same is true of terms such as "good" and "bad". Their exact definition and their attributes are not the problem of science, which has other hares to run after. Ethics (Sect. 2.6) is a matter of human determination and explanation, including the fact that sometimes there is plenty of hypocrisy hiding between what we say and what we do. Turtles and tortoises are crucial to the ecosystem and we do say so, but at the same time we destroy their maritime habitat and we built hotels and vacation homes at the pristine beaches where they deposit their eggs.

Another important point to consider in regard to science and ethics is that, according to some opinions, scientific effort is useful to society, whether it is moral or amoral. Indeed, one of the reasons science is considered to be basically

[12] In the end, science failed to save the state. Syracuse was conquered by the Romans shortly afterwards.

amoral is because, after discovery and truth, she recognizes neither good nor evil which, as it cannot be stated too often, are man-made values. Its driving force is:

- Discovery,
- Invention,
- Innovation,
- Change,
- Breakthroughs, and
- In many cases also funding.

Are projects undertaken for funding purposes moral, amoral or immoral? The answer cannot be unambiguous because much depends on the goals sovereigns and sponsors attach to scientific projects, as well as on the people and the means used to reach them. What is immoral is the use of other peoples' work without appropriate recognition and credit associated to it.

An example is a bizarre episode in the annals of science, which also constitutes a source of a feud in the world of AIDS research. Its origin dates back to the mid-1980s and it lasted for nearly a decade. American and French scientists have struggled to find a vaccine for the deadly human immunodeficiency virus (HIV), but they have also been battling among themselves over claims by the French scientists that their America colleagues had used a strain of HIV obtained from the Pasteur Institute in Paris to devise their AIDS blood test (in 1985).

The US National Institute of Health and its researchers vehemently denied this charge. The feud did not center solely on the credit for a scientific discovery. It also had to do with millions of dollars in annual royalties derived from the sale of AIDS tests. Then, in mid-1994, US health officials formally acknowledged for the first time that the virus used as the basis for the widely employed AIDS test had originally come from an HIV strain provided by the Pasteur Institute.

As part of a settlement, the US side agreed to revamp the complex formula governing the division of royalties from the AIDS test. But according to the official version from the French side, however welcome the money was it has only been secondary in the eyes of the Pasteur researchers. "This is official recognition that the virus was isolated in our labs in 1983," said Jean Castex, deputy director of the Pasteur Institute. "The extra money is not as essential as the recognition".[13]

This incidence leads our discussion beyond the point that science is amoral and into another of the basic principles underlying the scientific evolution: *creativity* and its compensation in credits and in financial terms. The concept of creativity is complex because it requires free thinking and an integrative personality. Besides that, a creative process is not yet well understood in its fundamentals, though hundreds of books have been written with 'creativity' in their titles. From what we do know, creativity requires:

- Experience
- Imagination

[13] *Newsweek*, July 25, 1994.

- Concentration
- Analytical ability, and
- A challenge that has to be met.

This is altogether a tall call, the more so as scientists are not necessarily free of preconceived ideas. For some, particularly those who fail to upkeep their skills in research and in experiments (Chap. 3) and in lifelong education (Chap. 5) time has stopped running and change is the least wanted element. This ranges:

- From resistance to dropping worn-out theories by adopting new ideas.
- To stagnation of projects in laboratories which consume resources but practically move nowhere.

Lack of coordination and the absence of critical designs reviews also play an important role. From 1986 to 1993 IBM, which at the time was a predominantly big iron (mainframe) company, had in its labs at White Plains five different supercomputer projects. They all died of old age at the workbench; none made it to the market. That was a curious (and destructive) policy established by top management and followed verbatim by the company's scientists. As users of computer power, some scientists.

Rather than spending time and money on the big iron, whose cost/effectiveness was low, in the late 1980s it was left way behind by the client-server model. Eventually, it becomes apparent that the word "advanced" attached to the supercomputer projects was hype—a vague aim very rarely if ever fulfilled. At the same time projects in the IBM labs should have concentrated on knowledge engineering and computer graphics including *virtual reality* (VR), while today applied research should focus on *augmented reality* (AR).

Computer graphics can be much more effective when viewed not on screens, but superimposed on real events can get. This provides for augmented vision because the real world is enriched with virtual text or graphics. While much AR technology is still in labs, research funding are increasing, with many ingenious applications emerging in fields as diverse as medicine, manufacturing, warfare, and entertainment.

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