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From Antiquity to Renaissance: The Early of Neuroarchitecture

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Abstract: ***Nowadays, in the so-called digital age, one of the most important findings relates to the perception that the human is not a machine and moreover, the human brain is not a computer. However, the latter remains a complex component of the human physique, which from the grey mass placed on the skull to the sensors in other parts of the body, has always tried to maintain human well-being. The human brain is born not fully defined; this means that it continues to develop in time through the investments of postpartum experiences. The issue dates back to the beginnings of mankind, when the primitive man tried to determine the optimal rules of living, thus defining the experiences or neutral experiences in the built environment. This kind of research that started from the human ego's modest efforts or even from the personal efforts that lead to increased lifestyle isreflected as a personal approach rather than a scientific one.Despite the technological interventions of recent years, it remains interesting that early architectural and urban solutions were based on neurological approaches, perhaps even limited, thus defining the origin of the principles of neuroarchitecture. This article focuses on analyses of Antiquity and then the Renaissance facing today's neuroscientific approaches and possibilities as typical models that precede the foundations wheredesign processes operate.***

Keywords: Antiquity, Renaissance, human brain, human proportions, neuroarchitecture

1. Introduction

According to Mallgave (2010), the Oour brain comes equipped with approximately100 billion neurons and a DNA complex of 30,000 genes, which were fully sequenced only in 2006. Within a certain physical context, the human nervous system forms special experiences. The way it works depends on the built environment; otherwise, as long as through the design disciplines can be reached, the creation of environments that evolve human living. The existence of this mutual relationship between the human nervous system and the physical context, in which the individual lives and develops, has been observed since early Antiquity and later in the Renaissance, thus creating a suitable base for the modernisationof JuhaniPllasma or JohnOnians'sneuroscience principles. This study aims to identify the foundations of neuroarchitecturewhile studying the work of Aristotle, Plinty the Edler or Al-Haytham in Antiquity, the work of Alberti and Leonardo in the Renaissance, facing today's neuroscientificapproaches.

2. Research Problem, Objective, Research Questions, and Hypothesis

Today, there is proof that mental health and the built environment are interrelated. Fred Gage dared to assert this statement while emphasisingthat as long as science had begun to accept that the surrounding environment affects the human brain by going even further as it changes our behavior. The interrelation between the nervous system and the physical space is much more essential than we thought. (PallasmaJ. MallgraveH. RobinsonS. Gallese V.2015,7)
Design processes appear as multidisciplinary as long as the final product comes as a result of the interaction between design and supporting science. Thus, the true values of architecture and urban planning are implied, which are not related only to formal, aesthetic, functional or even geometric views, justifying a given design task. On the contrary, as is said by Pllasma, their true qualities come by adding existential, emotional, embodied, and sometimes even poetic values. (Pallasma J. Mallgrave H. Robinson S. Gallese V. 2015, 10)

This article aims to identify the historical facts that prove the presence of neural logic in the early design disciplines.This issue is based on several key questions:

- When are the first traces of architectural developments,putting the human in the center, as a derivative of brain-body-soul trinomial?
- How did Antiquity define this philosophy? Who were the founding theorists and what were the conditions after which they managed to develop their work?
- What about the Renaissance?
- Started from Antiquity to Renaissance, is it possible that the fundamental principles can be still valid today?

Down below, will be found the answers to the above questions, which define the main hypothesis of this study: the neurological bases affecting the design processes are not current findings.

Despite how evolved this aim is among the modernisation of technologies, historical facts prove that the foundations are much earlier, both in Antiquity and in the Renaissance

3. Theoretical and Historical Framework of Neuroarchitecture

This article is based on two main approaches, man and the environment where he lives. Started from this statement and

moving towards the design or planning processes, it should be clarified that the main aim is to define man as a unique element, defined by the brain-body-spirit as well as the environment, the physical matter where he interacts (Pallasma J. Mallgrave H. Robinson S. Gallese V. 2015, 68). More than 2000 years ago, in the volume De Architectura (Published as Ten Books on Architecture), Vitruvius expressed the three qualities that processes of design have to be concentrated on. Specifically, by analysingthe object as the definitive product of the architect's logic, he defines as necessary values, its stability, usefulness and beauty (firmitas, utilitas, venustas)(Eberhard J. 2009, 753-756).Even earlier, primitive humans tended to choose the habitat where they lived (human selection) as a challenge to survival, thus strengthening the modern assertion that humans have always reacted psychologically when it comes to space. So, his sensitivity about the place, the built or natural environment all around, is a factor which has begun to develop theoretically in the last 50 years, despite its early origins.But nowadays, the issue is different.For this reason, while looking at the phenomenon from the point of view of an architect, Gordon Chong (2009) states that the only developments that have evolved design processes inrecent years are related to innovations in computer modelling of graphic design.(Eberhard J. 2009, 10)Perhaps this is why the modern architect and his relation with the design processes have been fading, as long as he, referring to technological, legal or even social coherence, is based only on the procedure while passing the task of design and continue to prepare the necessary material through the computer software and assisting during the construction process of the work, if it is needed. This was one of the reasons why in 2009, Chong appreciates the opportunities that enable a better balance between how it is designed or what, and also how and why it should be designed. (Eberhard J. 2009, 10) First of all, he suggests an interaction between architects and scientists to re-evaluate the requirements that are currently present in the disciplines, aiming at understanding the human response to environmental incentives.However, something had begun to change when in June 2003, in San Diego, was announced the opening of a relatively innovative academy whose mission would be to promote and advance the knowledge that connects data between the nervous system and urban and architectural development. The academy was named the Academy of Neuroscience for Architecture (ANFA). In the beginning, this academy benefited from the expansion of researches within the neuroscience community. At the same time, what is happening in neuroscience in recent years is considered the most exciting frontier of human knowledge since the Renaissance. In this way, the designers became partners in developing the implementation of this knowledge to increase further the ability of architecture and urbanism to serve humans. Thus, would arise neuroarchitecture as a discipline that aims to explore the relationship between neuroscience and the man-made artificial environment, believing that precisely this added artificial element has a significant negative or positive impact on the functioning of the nervous system.

It is important to be emphasisedthat every historical period has had its contribution in terms of design by the well-being and mental, and above all having in the center of attention, human. This turns out that all these attempts are founded naturally in the most primitive developments of mankind.

4. From Antiquity to the Renaissance

The term thatpersonifies the Renaissance era is related to the approaches that time had towards creativity, art, and especially towards the design process in particular. Thus, the term humanisationof architecture started to be known, which forced the world of design to be further oriented towardshumans. In this context, Mallgrave would analysethe aesthetic thinking of the time by focusing on the humanistic logic of the time, which he personifies with the so-called "human brain". (Mallgrave H. 2009, 9) Dating back to the 15th and 16th centuries,this movement was accompanied by major social changes after the Late medieval crisis. This philosophy was derived from the Roman concept of humanism (Roman Humanitas) as well as from Greek Antiquity among the philosopher Protagoras, who said that man is the measure of all things. It was precisely this approach that began to dominate the new aesthetic thought by contributing to art, architecture, politics, philosophy, science, or even the literature of the time. In terms of design processes, humanism had a slightly different connotation. Mallgrave (2010) refers to a double analogy to explain the humanistic approach to which the architecture of that era began to be oriented, seeing the latter as a metaphor for the human body and the human body as a metaphor for architecture.But, despite how the Renaissance period dates back to the Middle Ages, the point of reference it had was Antiquity, aiming at the redevelopment of the achievements of Antiquity. This is one reason why, rather than a historical period, the Renaissance is treated as a cultural and intellectual movement. Based on this principle, it is worth acknowledging that despite the resizing of humanduring the Renaissance, the phenomenon than human is the center of attentiondates back to Antiquity.

4.1 Antiquity

Nowadays, modern technology makes it possible to decipher specific notions thatrelate the function of the human nervous system to the environment around us, whether the latter in the form of an architectural work of art, focusing more and more on the psychological foundation of artistic perception. In fact, the foundation of neuroscientific resolution would go back to Antiquity through Aristotle (384 BC - 322 BC), who perhaps under the influence of the father of medicine, was more inclined to orient himself towards humanism as he saw the body as inseparable from the soul, otherwise by his teacher Plato.While the latter (Plato) saw the soul as something divine rather than material, Aristotle would refer to it as "the reality created by the human body together with the power to have life". (Themistus, Robert B. 1996)

On the other hand, the lack of essential information on the human nervous system did not stop Aristotle from expressing himself about the way the human sees the image/view. According to him, there are respectively two ways, the first the perceptual one and the second the imaginative one. (Themistus, Robert B. 1996) Of course, Aristotle was right, and this is acknowledged by the researcher of neuroaesthetic phenomena in art, Onians

(2007), who states that it is already accepted that the process of vision takes place in the brain and not in the eye. (Onians J. 2007, 22) However, Aristotle found it impossible to study the brain, so he focused on the study of human behavior, which he explains in detail in his Metaphysics. Terminologically it is about studying human nature, looking beyond physics and treatingas a single unity the physical and spiritual elements that characterisethe latter.

Furthermore, Antiquity hadother philosophers who managed to find the inevitable connection between art and nature. Moreover, the problem continues to be discussed apart from Ancient Greece in Rome, through Pliny the Elder (23/23 - 79). For the sake of truth, even the latter found it difficult to study the brain itself, although since the Aristotelian period, this was the first moment when an important neural element such as memory was discussed. (Onians J. 2007, 32) This statement equates memory with the flexibility of the brain and treats the latter as strongly related to the flexibility that nature has. It is this flexibility, the ability to adapt to human needs that make the environment around us so beneficial to man.

During the Middle Ages, it would be precisely the Arab views about the vision, represented by Al-Haytham (965-1040) and his publication Book of Optics, which influenced by Ptolemy's mathematics and Galen's psychology, would go beyond them. The first embodiment of this collaboration is given in the geometric diagram, which presents the schematic anatomy of the eyes, optic nerve, and brain. Al-Haytham supports Aristotle's view on the absorption of information by the eye but its processing by the brain.

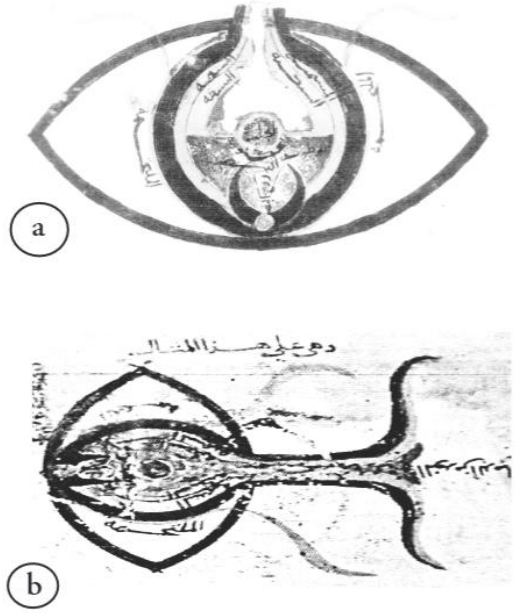

Figure 1: al-Haytham, drawing of eyes, brain and connecting nerves. Source: Anatomy of the eye from the view of Ibn Al-Haitham (965-1039). The founder of modern optics,Unal N., Elcioglu O.

According to him, vision actually depended on the influence through the light radiation of an object, then the transmission of information in symes to the organ, which he calls "sentient"and finally the interpretation of material from the brain through a process thatinvolves resolutionand the conclusion. (Onians J. 2007, 39) By studying mostly how vision is obtained, Al-Haytham, having no knowledge of the retina of the eye, insists that it is important to position the fixed object in front of the eye. Despite the lack of scientific information, he has become aware that there is a difference in visual acuity through the center and the eye's periphery. Today it is known that this phenomenon is caused by the greater concentration of light receptors in the central area of the retina. Analysinghuman's visual ability, he takes it further as he addresses the role of the brain in the perception of the image under observation. To make it clear,Onians (2007) takes the example of a rose and basil. According to him, man is predisposed to identify a rose faster than a basil leaf. While the rose appears visually more interesting, the basil leaf is lost in the myriad of green plants. (Onians J. 2007, 39) At that time,thisremains an accurate and valid statement. It is correct even today when as we know that our nervous system is equipped with special areas in the cortex of the temporal lobe, where specialisednerve cells are found andanalysethe various stimuli of the environment that surrounds us. Thus, al - Haytham contributed immensely to the developments of the Middle Ages between the publication of the Book of Optics, paying special attention to human perception and further investing in perceptual psychology. This would be the moment that favored the origins of Renaissance humanism, as Al - Haytham'sOptics was translated into Latin and found great use in Europe. Yet Greece, as a dignified representative of the time, was more focused and interested in mathematical innovations than in the developments of perceptual psychology. In the fourteenth century, through the translation of the theories of Al - Haytham into Italian comes into play Leon Battista Alberti, who directly and indirectly influenced by the above Optics, began to make the first contribution to the humanisationof art and especially design disciplines.

4.2 Renaissance

To analysehow the human nervous system began to respond to Renaissance trends, it is worth discussing three philosophies: Alberti, Vitruvius, and Leonardo, which Mallgrave (2010) unifies among the so-called "Humanist Brain"(Mallgrave H. 2009, 9).Alberti, referring to the school of Vitruvius, is probably the first thinker, who was able to announce a new way of thinking of architecture among his publications. His work managed to be appreciated until the XVIIIthcenturybetween the creation of a unified theoretical style concluded three artistic treatises: De Pictura (On the Art of Painting, 1435), De Statua (On the Art of Sculpture, thought to date around 1440) and the last edition realisedby him but the first printed on the theory of architecture, De re aedificatoria (On the Art of Construction, accompanied by ten volumes, 1443-1552). Alberti'swork also came as a result of his biography, favored by the wealthy adoptive family which minimally managed to secure his education at the University of Bologna, where he completed his doctoral studies in 1428. In fact, by 1434, Alberti was distinguished for his talent in writing and mathematics, a period when he broke away from Rome to Florence, forced by the Papal Court movement while contributing as secretary to the head of the chancellery. Moving towards an established hearth of a culture where he would befriend Filippo Brunelleschi and Donato Donatello, he would create a new approach to architecture, sculpture, and painting.

Nevertheless, he would still be inspired by mathematics, which he would apply in creating the basic human models of Renaissance art. While starting the foundations of the geometrytheory, he aimed at the humanisationof space. A typical example is relying on human geometry to create an ideal perspective, referring to the "average height of the human body". (Alberti L. B. 1972, 55) This tendency served to establish rules in painting, but it certainly also affected the art of sculpture and was quite evident in his treatise, referred to as the latter. Alberti provided an individualized proportional system thatwas based on the concrete case and not on the generalisedstandard. Vitruvius followed the same strategy, but unlike Alberti, who worked by referring to units and subunits for detailed accuracy, Vitruvius worked with fractions. However, these were only changes in methodology and not in the way they worked, as long as both authors focused on man and his well-being under aesthetic experiences.

Further, the publication which relates to the art of construction and refers to architecture, De re aedificatoria, relates precisely to the moment when his artistic ideas reach a real and thought-provoking conclusion. The same approach is referred to Onians (2007) as he asserts that Alberti relying on the biological logic by which the human nervous system perceives space, began to discuss rules on the design of buildings. (Onians J. 2007, 45) Alberti insists that buildings built with symmetry around a vertical axis are much more attractive than those that do not have this symmetry. He connects this statement with the symmetry that the human body and face naturally possess. According to Onians, there is an interesting assertion which further advances the judgment of Renaissance humanism. He thinks that inspired by Platonic works, rational logic, and referring to the regularity that characterisesthe human body, the lack of symmetry would oftentimes be a sign of ill health. (Onians J. 2007, 45) Thus, Alberti manages to formulate aesthetic preferences without knowing that they are biologically defined. The same theory is supported by Mallgrave (2010), who, referring to Albertii but implying the Renaissance humanists, states:

"According to Alberti, just as the body is a homefor the human body and soul, so the dwelling itself functioned as a home for the latter. However, unlike the human body, a building has the potential to bypass the inadequacies of perfect nature. It is important to invest in harmonious and proportionate elements or ornaments, which can be proposed by the divine power of reason. This should be the perspective embodied in a humanist architect"(Mallgrave H. 2009, 17).

Thus, was created the fixed image of the Renaissance, which strongly connected the well-proportioned body with the built environment and especially with the object, in particular, treating the body, mind, and soul as a unity that works in proportion. The same approach is further oriented by Fillareta, who was born eight years later than Alberti, followed the same logic and referred to the same body-building analogy. It is thought that they may have met in Rome, as claimed by Mallgrave (2010), who believes that Fillarete has managed to further the relationship that is created between the individual and the environment built during the Renaissance. (Mallgrave H. 2009, 19) Referring to the process of creation of the child, the latter explains the process of formation of the object, recognisingthat just as a child cannot be conceived without the presence of a woman, so a building cannot be built without the presence of an architect. (Mallgrave H. 2009, 19) Even further, he unifies the building with the head, as the most interesting part of human anatomy, where the mouth is the entrance and the eyes the windows. (Mallgrave H. 2009, 19) Thus, in continuation of the humanist thoughts of the Renaissance, a complete philosophy of architecture was being created which would be further represented by Francesco di Giorgio Martini and his treatise on civil and military architecturerelies on the ancient postulate but also respecting the renaissance logic, he believes nature and art are interrelated. Remaining faithful to Vitruvian thought and borrowing the typical Vitruvian human analogy, Martini would express:

"... Just as the human body proportionately organisesall its parts and to perfect measure, so the temples, the city, and the fortress must be conceived in the same way."(Lawrence L. 1983, 360-370)

Unlike the cases discussed above, Martin's figure begins to address the problematics of design processes on a larger scale using the human analogy at the city level. To return to the basic principle brought from Antiquity (through Vitruvius), but also applied in Renaissance practices, there is a desire to focus on symmetrical schemes. This logic reconfirms once again human anatomy as a pillar of inspiration as well as the conviction that the thinkers of the time had to humanisearchitecture and design processes. At the end of the XV century was reaffirming the relationship between the individual and the built environment, as it was said that the human body serves as a dwelling for the brain while the latter is accommodated in the built environment. Thus, a proportional connection of the individual and his anatomy with the city in general and the dwelling, in particular, was established. This attitude also managed to impress Leonardo Da Vinci, who, with the profile of a scientist more than an artist, invested more in understanding the brain and his anatomy. The dissection he performed in 1507 at the Santa Maria Nuova Hospital is still famous. Despite the dissatisfaction expressed by the church, the interest in further discovering human anatomy did not stop Leonardo from doing a series of anatomical studies and, as a result preparing precisesketches of the human body. He went even further, becoming the first researcher to further analysethe human brain, an organ so unknown until then. Mallgrave (2010) states that the study was conducted based on the medieval tradition that determined the brain's activity divided into three pouches or ventricles, which were placed respectively in a row behind the eyes. According to Leonardo, the first served as a receptor for sensory impressions, the second as a seat for the intellect, imagination, or even the judgment of the individual, and the third was responsible for the memory of the latter (Mallgrave H. 2009, 21).

Furthermore, Leonardo confirmed that all thoughts developed between a common logic that placed the brain at the center. Despite the way and accuracy with which the

brain's anatomy was read biologically, this statement is still worth treating as important today, as it possesses complete information that judges the connection that the human nervous system has with the environment around us. Interesting was the fact that Leonardo did not stop only at the sense of sight, the sense which for the time seemed to be able to perceive only the aesthetics and beauty that art offers. This view is also supported by Onians (2007), who states that Leonardo's experiences as an artist/anatomist and painter/musician were extraordinary, as they managed to give the latter the possibility of a unique approach between these privileged perceptions (Onians J. 2007, 52).

On the other hand, Da Vinci's studies had a special significance, especially in the second half of 1480, when his interest in architecture and its dependence on human proportions began to be noticed. Referring to his famous sketch, the Vitruvian Man (1490), Leonardo's inspiration from the work of Vitruvius, Alberti, Philarete, and Giorgio Di Martini is confirmed. An exciting period that influenced his work was precisely the acquaintance with the mathematician Luca Pacioli, who between his publication "Summa de arithmetica, geometria, proportions et proportionalità"(Arithmetic sum, geometry, proportions, and proportionality), oriented Leonardo towards the perfect mathematically universe.

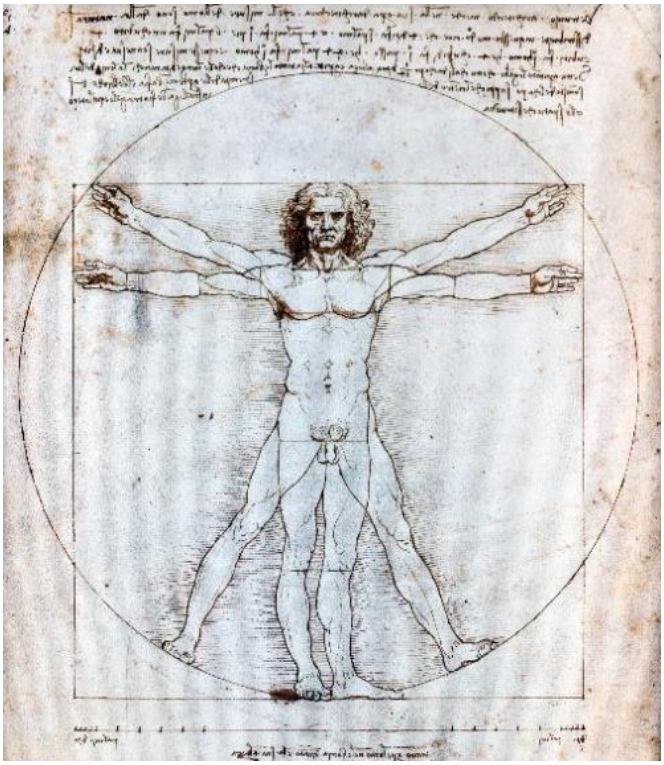

Figura 1: Leonardo Da Vinci, The Vitruvian Man. Source: The Vitruvian Man and the Rectangle of Fibonacci Dimensions, Gulcugil A.

In 1509 the collaboration "De Divina Proportione" (Proportion Divin) was published, where Leonardo contributed through sketches and geometric drawings. To summarisethe logic of the latter or even the tendencies to humanisethe art and creativity of the early Renaissance, it is worth quoting Pacioli, who, with the determination of a mathematician, states:

"We must first speak of the proportions of man because from his body emanate all the masses or designations, every relation, and proportion by which God reveals the deepest secrets of nature"(Wittkower R. 1973, 15).

Thus, given how Renaissance scholars were trying to relate art with man, a justified achievement was also the insistence on achieving the ideal city design. Based on the aesthetic principles which were analysedabove and inspired by perfect human anatomy, the concepts on which they focused the logic of urban design were organisedbetween radial or orthogonal paths, central squares, symmetrical and proportionately harmonious schemes. At the center of the composition again was the man.

5. Nowadays

But what happens today as technology has supported as much as possible the advancement of neuroscientific principles in design disciplines and beyond? As noted during the analysis of the general historical and theoretical background (point 3), architects, city planners, and urban planners already have the total capacity to analyse how our nervous system responds in a given context (EEG, fMRI, MEG, etc.). A significantachievement today is the accurate knowledge of the brain's anatomy, defining the areas responsible for the various daily activities of the human. The approach that professionals in the field have associated with this phenomenon still remains the issue.So, we are faced with a fact already known, as we claim that mental health and the built environment are interrelated. But what part of the design process is this statement? Thus, the problem becomes complex as long as its solution is obtained bycombining two disciplines that work at such different levels. We are talking about architects and neuroscientists who work together for a common goal: designing for well-being based on the functioning of the nervous system. It should be emphasised that the challenge of this collaboration lies in the individuality of each discipline, because while designers have units of measurement meter or centimeter and mainly to develop rely on market tariffs, customers, investors, etc.; neuroscientists measure in microns and are funded by research institutes, private or public. Also, if architectural and urban interventions tend to be done quickly and without delay, the sciences that study the brain can use all the time it needs. During the collaboration, disciplines often confront each other intimacy and the challenge remains not to interfere in each other's scope. Thus, neuroscience informs but does not interfere with designers' decision, as it can perceive how design elements affect human behavior (e.g.,which is the feeling that is caused by the use of a certain color in a concrete environment). On the other hand, physical interventions in the environment do not have to limit the field of neuroscientific research. In the end, however, discourse remains intelligent and necessary, as both disciplines deal with both interesting and complicated approaches, such as the built environment and the human brain.

6. Conclusions

This article takes for granted the relation between the built environment and the human. He considers the latter as a

genuine trinomial composed of the body-brain-soul. Nowadays, this relationship is confirmed more than ever, as long as technology and genuine knowledge of brain anatomy can confirm it. But the beginning starts earlier. It dates back to Antiquity or the beginnings of mankind as the human naturally tried to create optimal living conditions. The phenomenon was seen with a similar interest during the Renaissance when Humanism as a philosophy of life took off. In the center of most of the developing disciplineswas the man.

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