Efrem Piccin

GREAT PYRAMID EXPLANATION

A Scientific Approach to the Great Pyramid explanation

To my wife,

Who redeemed the savage in me

And gave me a family.

I
Preamble

Just like Emilio Salgari, I am writing this book without stirring away from my home, without ever having been to Egypt, and never having had an opportunity to visit the Pyramid of Cheops.
However, we live in the age of global communication, which can result in unexpected fruits.
My curiosity about the Great Pyramid has origins in distant times: I was very young when one evening my father told me about this monument describing it as a treasure chest of infinite secrets.
There were no other incidents, but that single episode was enough.
My experience as a teacher of physics has taught me that if you want to grab the attention of the often-restive minds of your students, you must first pique their curiosity in your explanations: if you succeed in this, you have arrived.
In order to accomplish my research, I was lucky enough to have good plans and numerous photographs taken on site by friends and acquaintances. The rest of the material I found on the Internet.
In particular, many of the photos that accompany my work come from the excellent website, www.egyptarchive.co.uk, owned by Jon Bodsworth. I also exchanged e-mails with him, and he was kind enough to take photos and measurements at Giza for me.
I do not know why, but recently Jon has closed his website. However, since the images I had downloaded at the time were absolutely necessary for me, I am still mentioning the URL of his discontinued website as the source of my photos.
I can't say how far this practice is correct, but without the aid of these and other photos that I have retrieved from sites of ordinary tourists, my argument would lose much of their effectiveness.
In this book you will find very few illustrations. It was unthinkable to incorporate all of the 400 or so images that were essential in the book. Instead, they are available in a special photo gallery on my site www.greatpyramidexplanation.com, which can be accessed by the password "nefermaat".
The references correspond to those of the text, so if you like puzzles enjoy a really challenging read. Finally, I do hope that readers coming upon images from their websites will be understanding and be gratified for the help they have given to me unintentionally. Thank you all.

II
Foreword

Every so often I re-read my manuscript. I tweaked something here, made a small correction there. Even so, if I put myself in the shoes of a hypothetical reader, I cannot help but say that this is a very complex book, certainly not suitable for everyone.

If desired, it can be read in a "light" mode, as if it were a story, or at the very least, the diary of my labors. But if someone wanting to challenge themselves seriously in this work—to understand all the details and place them within a general design —could find great difficulty in dealing with my work as a more careful reading could prove terribly indigestible.

To complicate matters, the revelations are often fragmentary; many parts have been inserted at intervals, perhaps even years apart.

I sacrificed the fluidity of the text in favor of detailed and complex descriptions, so the book as a whole, excluding the first fifty pages, seems almost a manual intended for insiders.

Keep in mind, however, that proposing a single solution to the Great Pyramid, consistent with all of the various details, is a tremendously complex undertaking regardless of the quality of the presentation; so do forgive me for not having done better.

There is always the option of reading it out of pure curiosity the first time and then reviewing it for an in-depth study, regularly checking the photos and drawings can be downloaded from the site.

Without the support of these images no one will ever be able to undestand.

Finally, I shall propose the profile of what I hope will be my typical reader: a person having at least some scientific expertise and, like me, infected by the bug of the pyramids— without being compelled to indulge in imaginative solutions far from our feeling. Four-five thousand years may seem like a lot but at the same time it isn’t, because while you may think you are different from the people then, like us, they too have suffered, loved, dreamed...

III
Introduction

One evening in January 2004, I was watching one of the many popular television programs on ancient Egypt, its mysteries and so on, when I heard in reference to the pyramid of Cheops that the ducts emerging from the King's Chamber point toward specific stars to facilitate the spirit of the Pharaoh for some unknown purpose... and then, immediately afterwards: the three large Giza pyramids were superimposed upon the image of the stars of the constellation Orion just because...

I would also like to point out that, given any two points set apart from each other, it would always be possible to construct the required triangle by placing the third component in the right place. As such, pharaoh Menkaure may have implemented this scheme, but we are not ready to concede that Cheops had ever taken it into consideration, nor Chephren. They had, we will see, much more serious motives to choose the locations of their monuments.

I am afraid that the majority of Egyptologists rather than coming up with technical explanations preferred to emphasize the socio-cultural issues—ignoring the scientific arguments which are certainly more indigestible and apparently incompatible with the skills of those times.

I preferred to think otherwise and instead tried to give explanations using our modus operandi, adapting it to the means and materials available at the time.

Following this procedure, I was able to take a different perspective and amaze myself beyond any reasonable expectation.

Of course, an explanation that makes sense is often less charming than a fairy tale; chasing fantastic theories is certainly much more exciting. But for someone like me the assumptions described in that television program were extremely unpalatable.

It did not seem likely that the construction of such a colossus should lend itself, in addition to the structural difficulties of the project, to other unpredictable variables. There are already too many problems, because of the particular nature of the work, to grant other oddities.

It so happened that, without realizing it, I was captivated by these problems, inventing more or less plausible explanations about the ducts, corridors, and all the other complications that the Pyramid of Cheops has to offer the curious from around the world.

Being an engineer and a physics teacher at a technical school and as such guided by rationality, I focused upon explanations, unusual perhaps, but sensible from the logical point of view.

I started by discarding *a priori* all the fantastic hypotheses so widespread and dear to fans of the genre. Indulging in mystery, complacency, and complicating one's life looking for unlikely matches with other unknown facts is a practice that does not sit well with my way of thinking.

Instead, I prefer beginning with the facts, and these speak of people who have demonstrated their ability to solve problems so complex that modern scholars are left gaping.

I also thought that a project like this could not be the result of a team effort, as is fashionable to say nowadays.

One can share a procedure or technique but not an idea.

I believe such a complex work was born in a single, formidable mind that thought long and hard, and planned even the lowest and most insignificant detail.

I know now that, by embracing this thesis, I had already been placed in a "heretical" position, compared to the most accredited theory such as a series of architects leading the project, with sensational reversal of strategy during construction, a funerary chamber begun and never finished, projects changed, abandoned or undertaken at a later time...

Ignoring it all, I continued undaunted on my way, working with passion and—why not? —even a lot of imagination!

At the beginning, I dedicated myself to the "Ventilation" Ducts and not just the upper ones. I particularly found those of the Queen's Chamber interesting, with their improbable handles, located at more than sixty meters up inside both ducts.

I was terribly intrigued, until I found at least a half-good explanation for them. I say half, because I did not understand, at that time, the necessity of their presence and did not know (I found out later) that they were blocked off at the surface of the walls and so never came out to the chamber.

Pleased with my partial success, I took interest in the other details too, trying to get all possible information about the location of indoor spaces.

To do so, despite being not too computer-literate (I am getting on in years), I experimented with the Internet. So I ran into a host of false explanations, half-truths, apparent occult fantasies, the proponents of the extraterrestrial (worst of all) and other oddities like that, all mixed with some sparse but probably true information.

Forced to separate the wheat from the chaff, I found myself in serious trouble. I began to ponder upon how to obtain reliable sources of information—without any fantasies of the eager, perhaps well intentioned, but terribly ignorant of the real facts.

At this stage of my work I had my first windfall.

I am a modest—shall we say a novice? —bridge player, ill-equipped since my memory is uncooperative which, as you know, is a fatal flaw in a card player. Well, getting up after an afternoon game with the usual friends, I got the inspiration to ask if anyone knew an expert on Egyptians... a miracle! One of my own friends directed me to an acquaintance of his, an engineer and a student of Egyptology, living in our very own area too.

The telephone meeting was not particularly conducive: imagine a serious person, devoted to special studies, asked by a stranger on the phone, if he can help with respect to the plans of Cheops "because I have some ideas..."

Add to it the fact that I am not exactly a skilled diplomat. I have no idea how I managed to intrigue the friend Giorgio Agnese to the point of welcoming me to his house one evening in late February 2004.

The fact is that I managed to interest him somehow and that kicked off a series of evening sessions during which I was introduced to at least the ABC of being an aspiring Egyptologist.

Agnese has a considerable library dedicated to ancient Egypt, including an excellent floor plan of the Great Pyramid, the work of Maragioglio and Rinaldi (at a later time, always with the help of Giorgio and another co-worker, I could complete my observations using more detailed and precise texts and drawings by Gilles Dormion).

Luckily for me at the time I did not know of some terribly complex details, otherwise I would have certainly been discouraged by the apparent impenetrability of the problem and perhaps abandoned ship.

I remember, in fact, that at one point some such thing tempted me.

I thank friend Giorgio (although very critical of my ideas) for encouraging me to persevere.

Without his support there would be no book to read today.

So I started dreaming a little and thinking a little, as in a game, but always convinced that behind the big project there was a single mind, and above all, that any particulars present in the Great Pyramid could be explained in terms of

structural requirements or features of the task to be performed, because I believe nothing was left to chance.
Every detail has been carefully evaluated and considered in the course of a long and meticulous planning that must have engrossed the architect in the early years.
Agnese and I drew up a timeline of the historical periods, explaining the history of various dynasties of pharaohs, and needless to say, the fourth is the one that intrigued me most of all.
Upon discovering that in fact the period of the great pyramids is concentrated almost completely within a century, my surprise was total. There are many other pyramids, but many are simply made of adobe and so have become shapeless heaps over the centuries. Only a very few have a colossal size and are built with stone blocks.
Among these, that of Cheops certainly deserves a special place, not only for its size but also because of the particular character of its interior spaces.
Also, thanks to the good offices of Giorgio, I discovered that the first major building constructed by overlapping blocks of stone is the Step Pyramid of Saqqara, although in reality it appears to be a work that has come about without a truly great initial purpose (photo **A01**).
If I understand correctly, the architect Himotep, an extraordinary man also for other reasons about which I know little, began an ingenious process of development from a mastaba dedicated to the pharaoh Zoser to erecting a structure that is the very first great pyramid of Egypt's history.
The limestone blocks in this case are more modest than those used in the pyramids of Giza (photo **A02**), but we are not in the right period yet. The fourth dynasty is about thirty or forty years in the future. This so imposing a structure, however, had certainly tickled the imagination and pride of Pharaoh Sneferu, founder of the fourth Dynasty and father of Cheops.
Once more Agnese’s aid was essential. He recreated for me the historical sequence of the three pyramids erected by Sneferu.
Given that the exact sequence is not certain, the information that has survived suggests that, for the first time, someone thought of building a colossal monument containing a chamber no longer dug into the depths of the rock, but located into the structure body (starting from ground level) using well-squared limestone blocks, laid with extreme care.
The man chosen to accomplish this task was Nefermaat, Grand Vizier of Sneferu, a genius and a scientist.

In his mastaba in Meidum, famous for the extraordinary geese paintings decorating the walls, the pharaoh gives him merit, referring to him as "son."
Many authors believe that the term "son" should be taken literally, and so he is called the "prince" Nefermaat.
Personally, I think this is unlikely. A child should be at least fifteen years younger than his father. Additionally, it would need another twenty years, optimistically speaking, to reach adulthood and acquire the skills making him a genius of his time and then allow him enough time to build three pyramids... I do not think that Sneferu could have enjoyed such a long reign; much more reasonable to assume that the word "son" is an honorary term.
Nefermaat has certainly been inspired by the work of Himothep during the erection of his first pyramids at Meidum by using the stepped technique and also inventing, for the first time in history, an inner room with all four side walls "projecting" in.
Concerned, and rightly so, about the weight that the cavity would have to bear, the architect created a unique method to protect the room inside: as the walls rise, they get narrower on all four sides by successive overlapping of limestone blocks protruding into the interior of the room (photo **A03**).
This is certainly the first evidence of this technique being used. It will be taken to its extreme in accomplishing the Grand Gallery inside the Pyramid of Cheops, and from thence evolve to perfection of the great roman arches.
Thus, Nefermaat invented the '"projection" technique which he shared with his son Hemiunu, who in turn became the architect of Cheops, making the most colossal work that the human mind has ever conceived in ancient times.
This Hemiunu is the hero of my story (photo **A04**), but the History was terribly unfair in relegating him to a very marginal role.
The lack of comprehension of his work has led to the presumption that that there were several successive architects during the construction of the Great Pyramid, and so the intellectual grandeur of its project is lost, depriving him of merit and fame that he certainly deserved to get.
Hemiunu grew up in the shadow of a great father, an acclaimed genius in life, and although he inherited from Nefermaat the wisdom that opened the doors of knowledge for him, I am afraid, he could not escape the subtle discomfort that comes from feeling "...the son of..."
I imagine that he conceived this work, daring beyond all limits, very much beyond what anyone dared to think of till to date, precisely because of his desire to break free from the uncomfortable shadow of his father.

Going back to the first pyramid of Sneferu, we see that the structure was subjected to a terrible structural collapse even before the end of the work, whereby the outer covering and some steps came tumbling down at the base of the colossus (photo **A05**).

The disaster, however, did not discourage the pharaoh who certainly must have been dazzled by the splendor of the building when, still intact, it soared into the sky of Egypt.

Learning from experience, Nefermaat leaves the stepped technique to be covered later on and starts building a second pyramid at Dahshur with the main body structured in the classic way.

We must keep in mind that no one before him had experimented in such titanic enterprises: the houses, even the larger ones, were built of mud bricks and rose to only a few feet. As a result, the architect could not benefit from the experience of others. So, despite his extraordinary talent, not even Nefermaat as yet understood the structural problems of these behemoths. He'll discover later, at his expense, that these gigantic buildings tend to settle over time and are subject to delayed tremors. So even his second work, before to be completed, began to show worrying signs: cracks along the corridors, changes in alignment... to the point of forcing the architect to adopt extra means.

The pyramid base was widened; the sides were accorded a gentler slope, and changing the inclination of the last stretch, resulting in the double-sloped pyramid that still looks fine, finished the whole work. Spectacular in its uniqueness, it has been preserved almost intact to the present day despite the initial deficiencies (photo **A06**).

We can testify to this good performance of the work now in hindsight. However, Nefermaat or his pharaoh may have feared the worst.

The fact is that, again at Dahshur, Sneferu built the third of his pyramids: The Red Pyramid (photo **A07**).

The success in this case was total. Nefermaat, finally grasping the manner in which these giants exert pressure on the ground, relinquishes his preferred angle and contents himself with a more modest side slope.

I will give you more details further, about the mathematical machinations of Hemiunu, but in my opinion there is no doubt that his knowledge has the roots in his father teachings.

I already told you not to be a fan of esotericism and I was determined not to fall into the trap of singular numerical ratios indulged by fans of this genre, but we cannot just turn away from the evidence because we do not like how it plays out.
I didn't care of the 51.8° slope angle of the Pyramid of Cheops until I discovered that the collapsed pyramid at Meidum initially had the same angle and also the double sloped pyramid, as reported, before the base enlargement, had an angle "nearly 52°".
I was very intrigued. Also, I found that no other pyramid was proposed in this particular angle (though perhaps it was used in the unfinished, or destroyed, pyramid of Zedefrà, the first successor of Cheops, referred to as usurper of Chephren).
It is clear that Nefermaat first, and his son later on, found something extraordinary in this angle, being unwilling to give up on this. Perhaps Hemiunu just wanted to achieve success where his parent has failed, but whatever had the great Nefermaat seen that was so special in this angle?
I wish I could claim this as my own work, but alas, it is not: someone has already noted that the apothem of the Great Pyramid and half the side of its base are linked by a unique mathematical relationship.
Their relationship is actually 1.618, which is not just any number but the number phi, accurate to three decimal places! Mathematicians calculate it as 1 / cos 51.8 °: cos 51.8 ° = 0.618 ..... 1/0. 618 = 1.618!
It is not possible to doubt that Nefermaat knew the golden ratio and probably realized the great significance of this number, the very essence of all that is beautiful and graceful.
It would be a mistake to attribute the knowledge of the phi number to the entire Egyptian culture.
This number appears here for the first time and is passed on from Nefermaat to his son as a secret to be guarded carefully. Then it sinks into oblivion for a long 2000 years, until the Greeks discover again "the number of divine grace".
As I give a last look to my work now, I sense anew the stature of the genius of Nefermaat.
Recapitulating all the innovations that are part of him, it is no wonder indeed. Let us see: he is the first true builder of pyramids containing at least one burial chamber.
For the first time we come across, in the chamber construction, the very new technique of '"projection".

This man insists twice on erecting pyramids in compliance with the number phi and transmits this obsession to his son. There is no doubt that he knows the importance of this number in the context of natural phenomena.
Perhaps he even knew the Pythagorean theorem or, at least, knew how to calculate the square root of a number, judging how his son Hemiunu pursued the relationships between entire noble triad (3,4,5,) to the point of proposing them many times in his work (as we shall see).
Not enough, inside the great mastaba of Nefermaat at Meidum (120m. x 68m.), dedicated to his wife Atet, geese of incomparable beauty are depicted on the walls (photo **A08** and **A09**).
I've read that this is also the very earliest example of a fresco, but frankly I think that a good design on dry plaster has been confused with the real complex fresco technique. Which is nothing short of science fiction, although very recently I found (photo **A10**) there is the representation of a monkey playfully pulling the tail feathers of a crane on a wall inside the tomb.
This paint has suffered from the ravages of time, but one can see that the colored parts have been applied into carved drawings, like an inlay.
The colors were mixed with the mortar and applied in the surface engravings... not a true fresco, but looks very, very like it... (photo **A10**).
Returning to the painted geese, they are extraordinarily beautiful, to the extent of being removed to show off their beauty at the Cairo Museum. One need not be an expert of art to capture the magic touch of the artist. Nowhere else, as far as I know, is found evidence of decorations so "real"... I cannot suppress a thrill in the face of such beauty and I think Nefermaat, like Leonardo, also possessed secondary talents... painting maybe?
I may mention that the decorations on the walls of the tomb of Nefermaat include numerous other designs, many of which with only sketchy outlines, as if suddenly the artist had suspended its work. Keeping in mind the mummification process takes at least three months, even in the case of the unfortunate death of the owner of the tomb, it would have been possible to finish the drawings yet, though perhaps hastily.
Sure, but what if the artist and the illustrious deceased should be the same person...?
Moreover, I wonder if this tomb is also the first ever evidence of burial decorations on the walls. I would, of course, defer to the opinion of the experts, but if true the stature of Nefermaat will be even more magnified...

Hemiunu was then following in his father's footsteps, or rather, was something more: genius and the son of a genius. Perhaps his father took him often to visit their sites showing this or that detail, warning him about the instability of the stone giants, as the mind of the young student, eager to learn, took his first steps towards knowledge, even dreaming of his big day...

Hemiunu turns out to be a prudent builder, more prudent than his father, more prudent than anyone else ever after.

The fear of an unexpected event—a delayed settling, a tiny twist—is ever present: prudence determines all his choices and through them, his whole extraordinary work.

Trying to understand the reasons, I identified with the role of the builder, imagining his fears, since everything could be compromised at any time and no prudence would be too great!

This explains to me the obsessive attention to some details, apparently of little importance, the reason why some devices have been doubled: for example one can see that he feared the tiniest of gaps between the blocks, even deep in the body of the pyramid, and had adequately provided to fill them by mortar and limestone chips.

The same care, for example, does not seem to be applied in the construction of the Chephren's Pyramid, which is so close to it in time and location. The photos show that often there are gaps between the blocks, but needless to say that only in the pyramid of Cheops there are upper rooms and the Grand Gallery.

Speaking about the pyramids, people often forget some important details: the Great Pyramid is not only the largest but, unlike all the others, its inner rooms are not built at ground level: they occupy the top center of the monument, an enterprise never attempted by anyone else.

I imagine, Hemiunu must have dedicated the best years of his own talent in this grand project and not had an easy time to get credibility for it. He would have had to explain to the learned men of his time, the how and the why of every single thing, at least as far as they could grasp it. I am convinced that Hemiunu had gained a so complex knowledge exceeding even his father's comprehension. So I ask you to be patient and follow me on this journey simply by curiosity, without prejudices, keeping in mind only the limit of functionality.

Nothing impossible from a technical standpoint will be proposed: extraordinary solutions, perhaps, but realistic according to the existing evidences.

Proceeding in this way, bit by bit, perhaps even unwillingly, you may share my opinion and then, maybe, who knows...

IV
General Information

For a start, it would be ideal to have a good plan so that you can have a clear idea of the exact location of rooms and corridors.
I obviously hope to catch the eye of the experts and of course they have an idea already. But keeping the amateurs in mind, I will devote a brief description of the interior and only that, since I'm not very concerned (out of negligence) with the external measurements, their relationships, and so on...
All that is known of the interior of the Great Pyramid lies on a single vertical plane that almost passes through the apex (figure **B01**).

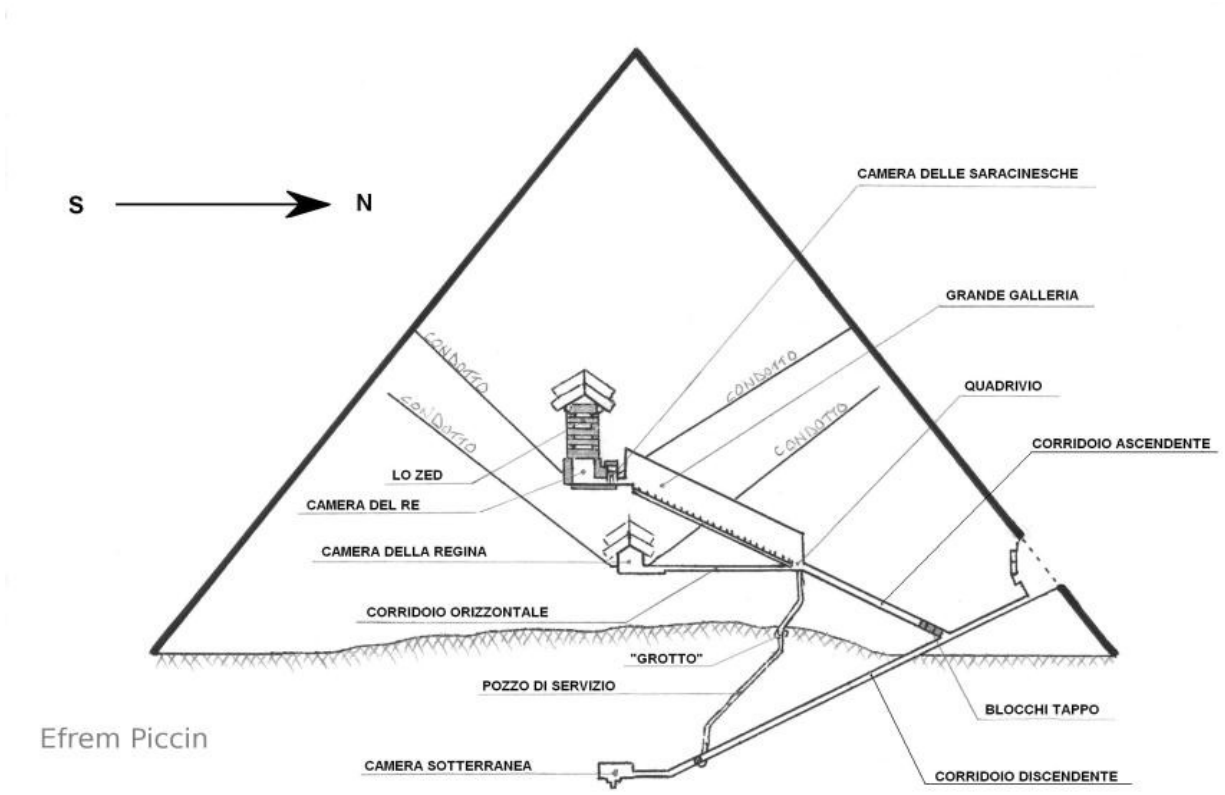

Figure 1: Section of the pyramid

Actually, this plane is parallel to the north south but offset 7.20m east from the center (a similar misalignment also exists in the Chephren pyramid). I suppose this is a trick to mislead any violators who would likely start digging into the body of the pyramid from a central location.
I also have another theory for this asymmetry, but I will keep it to myself for now.

On an aside, this measurement, provided by Maragioglio and Rinaldi, is not an integral multiple of the cubit, the unit in use at the time, and somehow it bothered me. Only recently I discovered that it is wrong. The latest surveys, carried out by R. Gantenbrink, speak instead of 6.82m and yes, this is a convincing measurement. In fact it corresponds to 13 cubits exactly!
The original entrance was at 17m height rather than the current 15.6m and flush with the external surface of the pyramid. It was (or should have been) probably well disguised in the pyramid outer surface.
Today this is rearmost, showing the Descending Corridor entrance crowned by a formidable structure consisting of two block rows arranged like two stacked trusses (photo: **B02**). This double structure is very impressive, too and I will return to it later.
Not being a professional writer, I have to re-read and correct all the time. I realized that my text contained some additional difficulties in addition to its inherent complexity.
To provide the best possible explanation it is necessary (in my opinion) that the arguments be dealt with in a logical sequence proven over decades.
To better understand I'll speak about my field of teaching, as example.
Thus, it will be appropriate to talk first of velocity, then acceleration—explaining that acceleration is the result of the action of force; force related to work, which in turn introduces us to the concept of energy and that will eventually lead us to speak of power.
Short-sighted psychologists have attempted to revolutionize the order of this sequence, forcing teachers (at least in Italy) to favor the "module" way: today we will talk about energy, forces tomorrow and maybe later the motions...
What, I wonder, can be more arrogant than that! Maybe (but I do not think so) in the humanities, it may be possible to follow a similar path. But applied to a typical scientific field, this system has generated a multitude of confused students, and at the same time, done a great injustice to the scientific method, which has its undisputed validity in the logic connection between cause and effect.
Personally I have always been opposed to such stupidity and possibly now things are going back.
It is not at random that I speak of my work. Often students know nothing of the topics that we show them and one gets the best results by following quietly and patiently along a path optimized by many experiences. Unfortunately, there are very poorly educated students who already have some knowledge (often confused),

keeping from going along the logic sequence by anticipating arguments. As usual psychologists say this is a good thing (because of the "participation"). I know for sure that it is bad for the quality of the explanation and especially for the understanding of all the class students.
By transferring this concept to the book you are reading, I can imagine the impatience of readers already "aware" about this or that issue, fearful that I may ignore or neglect some detail, or the chagrin of others who, intrigued by a particular point just mentioned, see it put off during the explanation when they would have liked an immediate clarification instead.
Since I intend to present the arguments in a particular order, which in my opinion will allow (where possible) the maximum of understanding, rather than continuing to repeat that such a issue will be explained elsewhere, thus complicating the reading, I decided to remove these references and to introduce a graphic symbol like (?...!) that summarizes the same concept, which is: do not be afraid, this thing will be explained in detail but at the appropriate time.
I hope I have made myself clear.

V
Unit of Measurement

The basic unit of measurement employed at the time of the fourth dynasty was the cubit, equal to 52.5cm.
In reality its exact measurement is somewhat controversial. Some authors opt for slightly different values but for our purposes the approximation to 52.5cm will suffice.
It was used along with its submultiples according to the Anglo-Saxon model: we find its fractions in half and in quarters.
There's more: the cubit was divided in to seven palms, where a palm corresponded to the classic four digits, *sui generis* measurement still in use.
It means that the palm should be 7.5cm long. A value confirmed by the facts. The palm, as stated, is divided into four digits (so 1 digit = 1.85cm.)
It is a worthwhile fact that the royal cubit was an extrapolation of the length of the human forearm.
At the Egyptian Museum in Turin, a cubit is seen in wood overlaid with gold. It belonged to the architect Kha (XVIII Dynasty) who lived several centuries later than the fourth dynasty time. On the instrument are represented human elbows, bent in three different positions: closed, straight, and open.
I imagine that the instrument had a trivalent function, allowing the conversion between three types of units used over the centuries or in the Upper, Middle and Lower Egypt.
Perhaps, at the time of the architect Kha, the cubit was shortened to be equal to a forearm but, if I check with my body measurements, I doubt that this transposition can apply to the royal cubit.
I am 172cm tall, and for those times I would have been a man of good size. Measuring from the elbow to the tip of my fingers of my open hand, I have 47cm.
If one wants at all costs to find an anatomical comparison to the cubit, the height of the knee to the ground comes to mind instead (try it).
That makes sense keeping in mind a man working has his hands occupied.
This brief discussion of units of measurement in use at the time is not unnecessary or pedantic. It’s purpose is to demonstrate how it had all been long pondered upon and planned from the outset, since all the internal and external measurements of the pyramid are "standardized," i.e. equal to integer multiples of the fundamental units.

According to that, the hypothesis of the overall project, where everything was planned from the beginning and built exactly the way it is, in my opinion is confirmed.
This issue is particularly important to me and is one of the key points of my argument, whereby my opinion differs very much from that of professionals.
I have already said that the Egyptologists are convinced that three different successive architects, from time to time altering the design of indoor spaces, have carried out the construction of the Great Pyramid at least.
Apparently they have good reasons to think so, but I am sure, at least about this detail, they are wrong and I hope to prove it successfully.
The second topic I consider essential is that the whole project was created fully complete in all its parts, but was also conceived by a single mind, a genius who gave us the most extraordinary work in human history, a work not yet fully understood if my assumptions were correct.
I hope to remedy that.

VI
The Descending Corridor

As I said, it all begins with a very well squared Descending Corridor, consisting, at least in its first part (30.28m starting from the current entrance) of good quality limestone blocks, well-positioned and rarely having a gap more than one millimeter in between.
The corridor measurements are of primary importance for my considerations: it is 1.20m high (2 cubits + 2 palms) and 1.05m (2 cubits) wide.
The height was measured perpendicular to the floor slope, so the net height, available for a standing man inside, is 134cm.
Also the other corridor, this time going upward, which I will describe shortly, has the very same measurements.
Returning to the Descending Corridor, its slope is strictly constant along its entire path, offering an angle of almost 26 and half degrees.
We will find this angle in the Ascending Corridor of the Grand Gallery, too, as well as in other pyramids, and also in all those tombs where the final closure was guaranteed by a convoy of well-squared stone blocks sliding down a slope.
It is obvious that, by placing a smooth block on an inclined plane and by increasing the angle of the slope, it will be induced to slide. The angle value is related to the friction coefficient (we would have to differentiate between the static from the dynamic one, but for now I'll spare you the spiel, after all we are not in class).
This coefficient depends on the two surfaces in contact, then by their grade of smoothing, and on the possible use of lubricants...
Having created a simple chute in the school laboratory and placed above it a granite block with quite rough faces (I realize that "quite" in science does not say anything, but just to understand...), having a slope angle of 26° or so, we are very, very close to the critical conditions. Often only a small nudge will switch it to the dynamic state: the block begins to slide, unable to stop any more (snowball effect).
The second reason, why this particular angle was widely used, is it was easy to reproduce: we must not forget that the people actually performing the work were often great craftsmen but certainly with modest theoretical knowledge.
It could not have been easy to specify to a worker of the time that the slope should be just that: nothing more, nothing less. But the random occurrence in this case given helps: a simple step having a 10cm high with 20cm tread is easy to build and, if the proportions will always be 1: 2, the angle will be always the same.

In Mathematics: inverse tan of 0.5 = 26.56°. Lucky chance...
This angle then simultaneously fulfills two requirements: it is easily reproducible and it ensures that the blocks positioned onto a slope like this, will slide all the way down by the first push.
Of course, the surface of the blocks must be machined smoothly and lubricated by pouring water or oil at the right time...
Let's return to the Descending Corridor of Cheops: the "constructed" section of limestone blocks is only thirty meters long. Thereafter the corridor continues with the same size and the same slope, but dug out of the limestone hill upon which the pyramid was erected. The total length is 104.7m (200 cubits). The corridor ends next to a curious frame (photo **B03**) intended (if my assumptions are correct) to be a stopper for the limestone (or granite) blocks that should have permanently sealed the pyramid.
However these blocks were never lowered in and, perhaps, remained unused outside (?...!).
Beyond this frame, there is a shorter horizontal corridor, 8.9m (17 cubits) long, leading to a large underground room carved into the rock.

VII
The Subterranean Chamber

The short horizontal corridor leads to a large Subterranean Chamber preceded, however, by a small niche carved into the wall on the west side.
The dimensions of the Subterranean Chamber are considerable even if they are not "standardized" referring to what I said about the unit of measurement.
It extends 14.05m long east to west, 8.25m wide from north to south, and is 3.10m high.
The room is noticeably unfinished: the walls, as well as the floor and ceiling, are still rough. Indeed, the whole west side is covered with large portions of rock not yet extracted.
Add to it the presence of a second horizontal corridor, absolutely blind, toward the south side and a well, roughly hewed only.
The sense of incompleteness is total: this place was never finished. Indeed, it is left just as if a new architect replaced the first and modified the original design.
For the sake of accuracy, however, I would like to explain the “non-standardization" of the internal measures.
For example, in the Queen’s Chamber and also the King's Chamber above, we would like to observe that the finishing of the interior walls were made *a posteriori*, starting with the rough room and finishing with the correct shapes by a painstaking removal of excess material. This strange (to us) way of working can be found at the room corners, where the stones are L-shaped as a result of a finishing operation like this.
The same process can also be seen in other monuments (photo **B04**).
According to this working procedure, even the Subterranean Chamber, had it been completed as planned, would have reached (in my opinion) final measurements in accordance with multiple integers of the cubit: the long side would be 14.17m (27c), the short 8.4 m (16c), and the height 3.15m (6c.) Given below are the actual measurements and those, which, in my opinion, should have been the final ones.
14.05m ----> 14.17m
8.25m ----> 8.40m
3.10m. ----> 3.15m
These measurements are by no means trivial (?...!). Note however that, even if the room has never been completed, the entire Descending Corridor is perfectly finished, at least up to the bottom frame I spoke above.

To explain the incompleteness of this place, I have to give you a brief explanation about the historical events preceding the construction of the Great Pyramid and its architect, Hemiunu.
Having understood that his father's problems about the pyramid had been originated from the poor substrate resistance on which it rested, in Giza he chose the largest among the limestone hills outcropping, hewed it out to lay bare the innermost part, and placed upon it his masterpiece, in such a way that his pyramid is in fact "wedged" on top of the rocky hill, obtaining also a secondary advantage of saving time and material in building.
Hemiunu built the Great Pyramid, an absolutely fantastic project, using the experience of Nefermaat, taking all possible precautions, doubling the planned devices, and constantly checking the parts already completed.
In the face of big dreams, however, the architect still retained the necessary modesty to fear and expect the worst: a late snag might occur, when the pyramid will be complete, waiting for the Pharaoh's death, frustrating the grand project.
If the worst did happen, since the mummification time was at least three months, Hemiunu still had the chance to finish the incomplete room, in the depth of the rock and seal it by a convoy of granite blocks, stacked outside, ready to be used in the Grand Gallery (under normal conditions), but which could also be used along the Descending Corridor, since the measurements were identical.
Note that the Descending Corridor, as well as being almost entirely excavated in the rock, is much more "sheltered" than the rest of the structure, so it is reasonable to suppose that it could escape any unfortunate structural collapse.
This, to me, is the only plausible explanation for the apparent abandonment of the underground project.
It is clear then the architect continuously monitored the finished pyramid: there are small traces of chiseling to restore the floor and walls alignment in the groove of the great gallery (?...!). Several authors admit the presence of these finishing touches.
Another much more glaring last minute intervention was carried out in the first room above the King's Chamber.
Perhaps after completion, a long crack was formed on the ceiling of the King's room along the east-west direction, almost close to the south wall (?...!).
In order to assess the risk due to this crevice and whether it involved the whole thickness of the large ceiling blocks, it was necessary to dig a duct, from the highest east point of the Grand Gallery south wall up to the first Zed room. The

duct was inspected during the Napoleonic era as documented by drawings of the time (photo **B05**).
It is due to this belated excavation that was possible to know the Zed complexity and find out the other "rooms" above (?...!).
I regret that my presentation is so discontinuous, but the project was not conceived to be told in a logical thread. I ask you, however, to have patience and trust; you will see that it will be worth.
I already said the pyramid is "wedged" on what remains of a limestone hill, evidently chosen ad hoc and adjusted as needed.
The local geological characteristics are also suitable for the extraction of limestone blocks necessary for the construction. So the quarries are very close, just a few hundred meters to the southwest.
There still remains the problem of transport: moving over 2,300,000 blocks over 20-25 years... these numbers make one think!
The local limestone is not very refined. It is a coarse-grained rock embedded with small-calcified marine organisms. This type of rock, however, constitutes almost all of the monument body.
High quality limestone was used for interior rooms, instead. The corridors, for example, are made with an extremely fine, almost white rock from Tura and the stone blocks, used in the Antechamber of the Portcullis up to all the rooms of the King's Chamber, including the Zed above it, are exclusively a granite from Aswan.
This is a very nice variety of granite with a strong deep red color, but from the point of view of construction the hardness of the stone must have posed some serious problems.
To us limestone or granite is only a matter of aesthetics or costs. But having to work by hand, without even the access to iron (the instruments of the time were made of copper, even if hardened by some particular technique or by the arsenic traces in the mineral base)—the matter takes on a whole new outlook.
I wanted to try, just to get an idea, with a good steel chisel. The crumbling limestone is easy to work, but everything changes with the granite. Since this rock is hard, the chisel tends to skid off and the result is just crumbling and breaking of the granite into unpredictable shards, since the breaks tend to follow the microscopic crystalline veins that run through the stone.
Of course, nowadays there are special steel blades capable of cutting easily, even rocks so hard, but 4500 years ago...

I have never seen the interior of the Great Pyramid. I do have, however, a large number of good photos taken from a colleague, Stefano Saraò, a professor in the same school I was and the second major help in my work. He became interested in my project up to bear a trip to Egypt not to mention the effort and expenditures, to produce the first (at the moment) of a series of models in 1:10 scale capable of describing how the individual parts work (at least, as I guess they would have).
These photos are a solid starting point for my study, showing details not included even in the excellent plans mentioned above.
In particular, I found very impressive the level of workmanship and finishing of the granite parts: blocks are squared and smoothed in an astonishing way. Having read that not even a piece of paper can be slid in the joint between two blocks, I realized that it is not just a manner of speaking: a piece of paper cannot be slid into the joints because all blocks of interior corridors, not just those in granite, underwent a bonding process with very fine mortars as the blocks were pushed together into place. The mortars were also used as a lubricant to facilitate the final sliding, the ultimate goal being, however, to permanently seal the blocks so coupled.
This kind of mortar deserves a detailed study, because mortars of different quality were used.
For example the small gaps between the limestone blocks constituting the raw body of the pyramid (the size of a few dm^3) were filled by poor mortar in a coarse way.
High quality mortar was used instead in the King's Chamber, the Grand Gallery and the interior corridors to seal the blocks.
It is worth pointing out that the hardening of a sealing mortar can be in more than one way: the basic product is a lime which hardens by reacting only with carbon dioxide of the air. The Romans discovered that, by adding powdered lava to the mortar, the mixture was capable of reacting even with water; indeed, water was precisely the active agent, as in modern cements.
It is likely that even then the Egyptians were using mortars of the mixed type with a first reaction due to the use of water, followed by a subsequent further hardening by the action of the air.
Mortar comes from calcareous rocks, crumbled and then calcined in special ovens. It this way calcium oxide called "quicklime" is obtained. This substance, when ground, and mixed with water turns into calcium hydroxide. This gives the "lime" or "putty" in the form of fairly consistent dough.

The putty is subsequently milled and mixed with inert powders (fine sands in the case of the Egyptians), brought to the correct density by controlling the percentage of water and finally laid on site. This is a common lime, whose hardening is not as rapid as the cement one. The chemical reaction that gives the necessary mechanical characteristics is completed through the absorption of carbon dioxide.

The calcium hydroxide in the presence of CO_2 is transformed into carbonate, returning to the consistency of the excavated rock, exactly like before being treated by heat.

The problem is that the carbon dioxide will have difficulty reaching the mortar in the inner area, knowing that many of the blocks are over one meter thick and that the joint gaps are even thinner than one millimeter...

We know that the Romans placed burning braziers on the site in order to produce an abundance of the necessary carbon dioxide just to hasten the process.

Dormion, in his excellent description of the interiors of the pyramid, describes the presence of an "ocher patina" that covers all surfaces of rooms and corridors, as if it were a kind of final painting...

I believe instead that, following completion of the interior rooms, while still the pyramid was under construction, Hemiunu arranges to complete the hardening of the mortars by maintaining constantly lit oil lamps, so as to ensure a high concentration of carbon dioxide, even in the inner part of the very thin and narrow joints.

These lamps had probably burned continuously for years. No wonder their smoke is deposited on the walls, thus creating the "patina" described...

Going back to the granite: Hemiunu must certainly have had good reasons to use this type of stone despite the problems that its use would have entailed—timing problems also, since the blocks, due to the distance and working time, probably had to be required years in advance.

We should not be deceived by modern technology: using the means available at the time, preparing blocks like those of the Antechamber of the Portcullis and the Zed room required a very long time to complete. This also supports my idea of an overall project, conceived by a unique mind.

If what I believe is true, we will find more details intended to serve a double purpose, perhaps at different times, or doubled simply from prudence (e.g. ducts of the King's Chamber or those of the Queen's Chamber).

Returning to the layout of the interior spaces, the Descending Corridor has a major bifurcation at about 25m from the entrance: from its ceiling a second path starts, going up having the same slope and the same size of the previous one.

VIII
The Ascending Corridor

In reality, however, things are not so simple since the point of intersection has an absolutely extraordinary peculiarity, creating a concentration of such and so many complications as to appear as an impenetrable mystery (?...!).
Firstly, someone stopping under the bifurcation and looking up at the new corridor would only see a formidable granite monolith, ominously looking at him from the ceiling as if it were about to fall on an unwary onlooker (picture **B06**).
This block, however, cannot fall off since the ceiling block is shaped in such a way as to “clamp” it on the sides. Also the block itself is machined to a wedge shape adapted to fit perfectly into the above-mentioned stone. The block simply cannot fall because the opening is smaller than its widest side.
If it were not for this bottleneck, not only would it fall, but also the other two blocks behind it, which were presumably slid there along with the first from the top of the Ascending Corridor, would follow it.
It is impressive to note here that there are only a few millimeters of clearance between the blocks and the walls of the corridor. It is possible to observe these blocks because there is a side passage (from which now also the tourists enter) dug by Sheikh Al Mamun who was the first violator of the monument (?...!).
It is clear that these three blocks sealed the pyramid, preventing access to the higher areas.
Only the first (lowest one) is wedged on the sides so it gets stuck in the ceiling of the corridor. The next two have instead the traditional, rectangular facets, with measurements just inferior to those of the corridor in which they had slid with the first one.
To conclude the description of the three blocks, it is necessary to observe that the last of the three, the top one, is incomplete in its outer half, as if someone had tried to demolish it and probably this is what happened (?...!).
Ultimately, only the second of the three blocks, the middle one, is complete and "regular." For this reason I make a reference to it, imagining that these measurements may also be representative for all other missing blocks; many details suggest that, at least in the initial project, the blocks for the closure were to be many more than three, 25 to be exact and I am not the only one who thinks so.

By the way I have already said not being an expert on the Egyptians: Agnese is the source of my historical knowledge, so it may happen, in many cases, that I have "discovered" trivia known to all.
Sorry for these naivetés, but I am in good faith. I do not know what other authors have said about this or that detail. Since I have arrived at a conclusion by thinking independently, this can be original for me, but as I said, maybe for others it is self-evident. Forgive me then, but do trust me a little, for many of the things I have to offer are not trivial at all. In fact, with some of these I will certainly attract the thunder of orthodox scholars, but since I have no reputation to uphold, I have the chance of freely expressing my opinions.
I guarantee, however, that my remarks will always be plausible from a scientific perspective. I may make assertions that are not shared, but anything I'll say can never be an insult to the intelligence.
I am convinced I have come very close to the truth and it is a truth that is nothing short of stupendous!
Let's talk about this granite block as representative of the other 23 (the first, we have seen, is abnormal). It is 119cm high (just under 2c + 2p), 104.5cm wide (almost 2c) and 170cm long (3c + ¼ c.)
Since it is granite, its weight must be about 5600kg: a really daunting proposition for any violators of the pyramid!
If fact, if some unwary person working from the Descending Corridor, makes free by chiseling the first block, he would have had the unpleasant surprise of seeing the whole block convoy fall, if the 25 blocks had all been there. And well, it would be a long time before the Ascending Corridor could be accessed...
It seems this idea must also have occurred to Sheikh Al Mamun in the year 820 A.D. when he first broke into the upper areas of the pyramid.
In this enterprise, he engaged many men with iron tools, working in the daylight without being forced to work in secret as the tomb violators do. In my opinion, Al Mamun entered through the proper entrance, since it probably had never been completely hidden as conceived in the project, and dropped down into the Subterranean Chamber without finding the treasure he sought. Certainly the presence of the block in the ceiling must have appeared suggestive, and dangerous...
Suspecting deception, the Sheikh undertook an excavation in the limestone of the pyramid body starting from a position just below the intersection of the two

corridors. The excavation went rising and moving laterally the blocks until it emerged on the west side of the third one.
I guess at this point Al Mamun started the demolition of the block realizing that it was the last and behind it the corridor was accessible (even if with difficulty, as we shall see).
I do not know if, at the time, the secret of the three blocks was known, but I am inclined to believe it.
And I think that during the pyramid construction, the occurrence was an excellent topic of discussion and every detail was publicly known: what else would the vast multitude of workers talk about in the evenings?
I guess then that the supposed inviolability of the monument was touted and described everywhere. So the extraordinary locking mechanism, conceived by Hemiunu, sealing the only access by 25 granite blocks, should have been no secret.
(Note: The "Service Shaft" will be dealt with in another part).
I can almost imagine the formidable 25 plugs, well aligned at the pyramid entrance, waiting for the big day...
It is certain, however, that something went wrong (?...!) because only three blocks were used and surely it had to be publicly known.
The pyramid was in fact almost totally defenseless despite the formidable locking mechanism and the people certainly passed on the memory of this vulnerability.
All this just to say Al Mamun, perhaps through ancient texts, could have known the real size of the block convoy, because he seems to have made "a beeline" to it: the tunnel he carved in the pyramid was too direct, too focused...
So, the Sheikh managed to penetrate the pyramid but with unsatisfactory results, if we give credit to his account. The interior spaces were cluttered terribly with all sorts of debris: limestone and granite broken blocks, beams, crushed stone... so that, in order to climb up the corridor, it was necessary to empty all the obstructing material. For that reason only, now I know, Al Mamun dug the horizontal passage, starting from here and leading to the outside of the pyramid.
What is now the tourist entrance, known as "entry of Al Mamun,", is actually (in my opinion) "the Exit of Al Mamun": it was a convenient exit to bring out the immense amount of debris accumulated in the Ascending Corridor without having to carry it uphill to the proper entrance.
I point out that this horizontal path ends just behind the three blocks and from here it is possible to go down to the corridor below through a vertical tunnel dug in the

pyramid body: if Al Mamun had gone in from the entrance that bears his name, he would have no reason to dig down to the lower corridor.
It is more reasonable that things have taken place the other way around. The Sheikh had entered down from the proper entrance to the Subterranean Chamber and only at a later time climbed up to three blocks by digging the passage (?...!).
I add a small detail that may seem insignificant right now, but in another context will instead be important: the granite block higher up, that now appears to be incomplete, was intact before Al Mamun, since Petrie wrote about the presence of mortar at the bottom of the Ascending Corridor in which, just where there was a front lower corner of the block—now missing—there is a small granite fragment inside, as if it were belonged to the fractured block.
Going along the Ascending Corridor, there are three remarkable stone rings surrounding the corridor like a sheath. These are called "girdle stones" made by two blocks embracing, from both above and below, the corridor, which passes through them according to a complex design (?...!). The three "girdle stones" are exactly 10c (5.25m) apart. The first one is located 35c from the intersection of the two corridors, and since the overall length of the corridor is 75c (39.27m), the last of the series is 20c (10.5m) from the top exit.
The complications of this stretch are still not finished: downward every stone rings, small prismatic stones are centrally inserted in the walls, the reason of which is difficult to explain... (?...!). This corridor ends at the top, in the most singular aspect of the whole pyramid: a complicated intersection that some authors call Quadrivium.

IX
The Quadrivium

In this area, too, are found a variety of complications capable of putting a strain on the understanding anyone.
The ascending corridor ends up at this point, to be connected to the Grand Gallery.
The two floors are perfectly aligned with each other, despite being separated by a space 10cubits (5.25m) long.
The break is made necessary by the presence of a third corridor that runs horizontally south to the Queen's Chamber (figs. **B07** – photo **B08**).

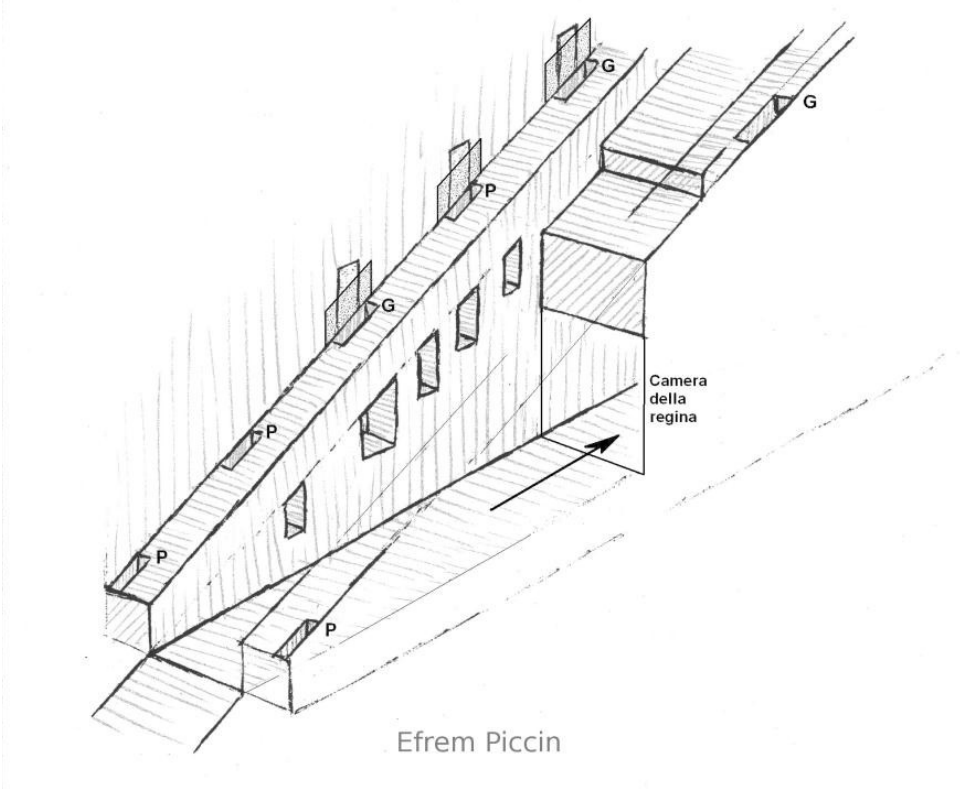

Figure 2: Quadrivium

Since all the three paths are coplanar, any load can be taken uphill, overcoming the lack of the floor, thanks to a removable bridge consisting of five wooden beams placed across the path.
Removal of the bridge, however, frees the access to the Queen's Chamber.
The five beams had to be inserted into ten trapezoidal niches carved into the side walls, but the depth of these niches as well as their corresponding distances are complicated to analyze.

Some beams could only be entered from the right side, others from the left.
This is perhaps to streamline procedures and to ensure that groups of men at work could overlap each other without getting into each other's way.
The beams themselves were not equidistant from each other, nor even did they have the same width.
Another detail: if we imagine the five beams in their places as described (photo sequence **B09** through **B14**), we would find, beyond the highest beam, the floor is still lower for a length of two cubits. The same level will be re-established by an unusual step upstairs (detail visible in the photo **B08**).
However, putting aside the due explanation for this apparent inconsistency, which will be given in another section (?...!), I imagine that, in this cavity, five or six wedged beams were arranged parallel to the slope, shaped a little like a "mostacciolo" in order to be able to rest against the first beam, thus completely filling the gap in the floor (photo sequence **B15** through **B21**).
This ingenious junction is made even more complicated by the presence of a fourth passage, made *a posteriori*, and created by digging into the body of the pyramid. It starts from the very beginning of the horizontal section on the west side, going straight, and then follows a very complicated downward path that will take it far below to a level just a few meters before the end of the Descending Corridor, emerging into its west side with a "gooseneck" path.
All this after changing the slope several times and having passed through a sort of natural cavity called "the grotto". For this purpose a square section vertical shaft was constructed "ad hoc" with limestone blocks. The whole is commonly called "Service Shaft" and assumptions about the real function abound.
Naturally, yours truly has ideas about it, too (?...!), but instead I'll return to the Grand Gallery as this is the part I want to describe first. Although missing the initial portion of the floor to accommodate the horizontal passage to the Queen Chamber, when it starts again, it is, as I said, perfectly aligned with the Ascending Corridor. It then goes upward until it comes to a big step; going over this begins another short horizontal passage through the "Antechamber of the Portcullis" (?...!).
This is a smaller room, little more than three meters (6c) long, intended to accommodate three large granite monoliths, lowered into six side guides, providing effective a closure to protect the big, all-granite crypt called the King's Chamber (?...!) where is the famous and mysterious sarcophagus, found damaged and without its cover (?...!), according to the report of Al Mamun.

Inside the King's Chamber, in the north and south walls, there are two narrow ducts which, going horizontally across the granite block of the walls, climb then up leading outside to the same altitude (?...!).
Two other similar ducts were discovered within the walls of the Queen's Chamber, but having different characteristics from these (?...!).
The brief general description is done; we can begin to look more into the Grand Gallery details.