How The Pyramids Were Built:

The Theory of The Conjoint Solution and The Shrinking Dual L Notch Ramps

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The Mission

At the culmination of five decades of effort the mission empowering this work is clearer than ever. To put to bed all the conspiracy theories of pyramid construction which seek to deny, diminish or detract from the incredible achievements of the Ancient Egyptians. In doing so, to fully and unequivocally restore the credit, respect and honor rightfully deserved by the Ancient Egyptians for the astounding genius of their audacious vision of the Great Pyramid, and the staggering achievement of bringing it to life using the ingenious methods and techniques finally explained here, with irrefutable proof, fully consistent with the methods and building techniques from the historical records of the era of the Great Pyramids.

I also want to acknowledge my enormous debt of gratitude to Dr. Zahi Hawass. His life's work, his unparalleled contributions to Egyptology and Pyramid research, his enormous impact on Archaeology and his name will forever be linked to the Great Pyramids and have served as my lifelong inspiration for all the decades it took to finish this work. I continue to benefit from his invaluable advice and guidance as I take this work forward.

- Rajan Hooda

All Hail The Ancient Egyptians!

How The Pyramids Were Built

- Rajan Hooda, PhD.

I am an Archaeology and History enthusiast who, in the foolishness of youth, mistakenly stumbled into a life and career in Finance. Fortunately, my passion for Archaeology and History survived my unfortunate detour.

Upon exiting this detour, somewhat intact, I redoubled my focus on the more pertinent life interests that I had cultivated. Egypt's magnificent pyramids were on the top of that list!

I was 8 years old when I first learnt of the pyramids. I was instantly captivated by them. What was even more amazing to me then was to learn that over the past 4500 or so years no human had been able to solve the puzzle of how they had been built. Maybe that made it the greatest mystery, the most difficult puzzle, in the history of Humanity!

That challenge gripped my mind like a vise. It fired my imagination. It sent me on an intense problem-solving rollercoaster to try and chip away at this ageless mystery. Five decades of effort later I was finally able to put the last painstaking pieces of this immense three-dimensional jigsaw puzzle into place.

Note: For details and press coverage on this research work or to download a PDF version of this paper visit the website dedicated to this work www.HTPWB.com an acronym for '**H**ow **T**he **P**yramids **W**ere **B**uilt'.

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Introduction

The largest of the great pyramids was built for pharaoh Khufu and is named after him. It was built around 2550 BC. It was constructed using more than 2 million stone blocks which weighed an average of 2.5 tons each. The exterior of the pyramid was covered by smooth white limestone casing. Originally completed to a height of 146.6 meters (481feet) it stands today at a height of 138.5 meters (454.4 feet) due to loss of the capstone and of casing stones and removal of some of the uppermost layers. It was originally built up of around 210 layers of which the upper 9 layers are missing. The lower layers have the largest stones of around 5 feet height and the height and weight of the stones gets smaller (though in some layers this reverses) with the uppermost layers being about 1.5 feet thick. Its construction is estimated to have taken around 23 years (Muller-Romer 2008).

There have been various ideas proposed for the construction of the pyramids, none of them ultimately convincing because of the difficulties each of these approaches entails. Use of levers (Herodotus 1972) to raise stones is possible but how levers are used to raise stones reliably more than 400 feet is unclear, as is the problem of using this method to raise the more than 2 million stones needed. Use of water and hydraulic mechanisms has been suggested for the Step Pyramid of Saqqara (Landreau X 2024). However, there is no evidence of the ‘elevator like’ vertical cavity in the middle of the pyramid nor are there specific explanations of how such a mechanism would work.

The Egyptians were very familiar with the use of ramps whose remains have been found in various places like Karnak (Parry 2004) as well as the quarry site near the Sphinx (Smith 2004). Remains of ramps show they were built using broken stone, tafla (Hadingham 1992) and mud – materials available in great quantities in and around the Giza plateau. As a result, researchers have suggested several possible ramp theories. Let us now examine these.

One proposed theory is the use of a straight exterior ramp to raise the building blocks to the top of the pyramid. However, calculations show that such a ramp would have to be of such a long length (possibly one km long) and size that the material used to build such a ramp would be more than the material used in the great pyramid itself (B. Brier, How To Build A Pyramid 2007). Further, no evidence of such a gargantuan ramp or the disposed remains of its dismantled materials has ever been discovered. Also, a large ramp would have covered a significant part of the quarry in the south that was used to provide stone for the Khufu pyramid (M. a. Lehner, Giza and the Pyramids The Definitive History 2017).

An alternative ramp theory is of an exterior ramp supported by scaffolding attached to the exterior of the pyramid and spiraling up the pyramid to the top. This theory is even less plausible given that no scaffolding attachment points exist on the face of the pyramids. Also, no scaffolding would survive the weights and movement of the sheer number of stones being slid up the ramps used in the pyramid's construction.

A second version of the exterior ramp theory is a hybrid ramp theory using a straight ramp for lower levels and later an accretion layer for higher levels (M. Lehner 2004). Here the higher levels were reached by an external ramp supported by an accretion layer that wrapped around the pyramid. This accretion layer would mask the face of the pyramid as well as the corners, making the pyramid architects' task of maintaining the angle of the pyramid, and keeping the face of the pyramid flat and straight, almost impossible to do (M. a. Lehner, Giza and the Pyramids The Definitive History 2017). Lastly, the proposed ramp at the highest levels is required to be at an 18 degree angle – such a steep slope would prove very challenging to drag stones up, even if the stones are smaller at the highest levels (M. a. Lehner, Giza and the Pyramids The Definitive History 2017).

There is evidence of some kind of a ramp from the quarries to the south of the Khufu pyramid extending to the Khufu pyramid's southwest corner. This ramp was likely used as a supply ramp to drag stones from the base of the quarry, which was at a lower level than the base of the pyramid due to the stone mining. Since the purpose of this ramp was only to bring stones to the staging area near the base of the pyramid it would not have been a high ramp, just a supply ramp not needing much material for its construction. This would also explain the absence of any large debris field of ramp material when this ramp was dismantled.

In 2006 a French architect Jean-Pierre Houdin (Houdin 2006) suggested that the pyramids were built using an internal ramp spiraling upwards like a tunnel inside of the pyramid. This theory was further developed along with the Egyptologist Bob Brier (B. a.-P. Brier 2008). No evidence of such a complicated internal structure has ever been found archaeologically or even with the use of radiological surveys which penetrate the pyramids revealing its internal structures (Procureur S 2023). It is also not clear how the outer casing stones would have possibly been put into place from an internal tunnel like ramp. Further, it was suggested that the internal ramp was 6 feet wide (B. Brier, How to Build a Pyramid 2007). Such a narrow ramp could not possibly accommodate two-way traffic of ascending and descending workers with sleds. The biggest challenge would be the lighting and air ventilation of these long interior passages for hundreds of workers to simultaneously navigate.

None of the other ideas, e.g., alien construction, really survive serious scrutiny. This brings us to the present moment and the reason why this perplexing problem of how the pyramids were built has remained unsolved for around 4500 years.

The external ramp theory has the advantage of simplicity of construction technique but it has the disadvantage of sheer scale and lack of evidence of such a massive ramp or it's remains. The internal ramp theory aims to solve for the massive ramp problem and has the advantage of not needing additional construction materials but has the disadvantage of extreme complexity and lack of internal structural evidence.

In struggling with this age-old problem, it seemed that the solution to this problem had to *have the advantages of both of these theories* - a) simplicity of construction, and, b) not require additional construction - as well as *not have the disadvantages of either of these theories* – and c) explain why there is no lack of evidence of the construction technique used. This seemed to be an impossible list of requirements for any one building technique to meet. After trying to address this vexing problem in innumerable ways unsuccessfully, at long last an epiphany slowly dawned - *the Ancient Egyptians had used a ramp that was, simultaneously, Both Internal and External!*

How The Pyramids Were Built

Let us start by using an analogy, and a thought experiment, to explain this approach. Let us imagine that there exists a natural stone mountain which is the exact shape and size of the great Khufu pyramid. Now imagine that tourists want to get to the top of this unique mountain so the nearby town decides to build a road that goes to the top. They blast away rock to create a road that goes gradually up and up and round and around the mountain till it reaches the very top. At the sharp 90 degrees mountain corners they make deeper cuts into the mountain to create a smoothly curving road so the cars can easily make the 90 degrees turn from one flat face of the mountain to the other flat face. The cut that the road builders made into the face of the mountain would look like a notch shaped like a giant letter L. The road is the lower flat part of the L and the sheer vertical cut made into the mountain at the side of the road is the like the vertical bar of the letter L. The road itself is nothing other than a ramp used to move cars (or loads) up or down the mountain.

The L Notch Ramp

Now let us look at how the Ancient Egyptians used this brilliantly simple and simply elegant method to build the most magnificent structure in the world.

The Khufu pyramid is like a layer cake originally made of 210 layers of stone blocks (Petrie 1883). So, it was meticulously built up one layer at a time. Let us start our journey at the lowest layer - we will call it Level 1.

First the Egyptians prepared the base of the plateau upon which they would erect the pyramid. Then they dug into the base of the plateau to build the subterranean passage and chambers which lie below the Khufu pyramid. Once this was completed, they were ready to start assembling Level 1. The stones at Level 1 are approximately 4.5 (1.5 meter) feet high (McKenzie 2016). The stones were pushed into place until Level 1 was almost complete. The only part of Level 1 not complete was one corner of Level 1. The corner part that was incomplete was a rectangle measuring approximately 10 feet wide and 25 feet long. Now the Egyptians who are expert ramp builders built a small ramp in this space rising from the floor level to the top of Level 1. This ramp was 10 feet wide and around 26 feet long built, e.g., at a 10 degrees slope to reach to the top of the 4.5 feet high Level 1. It was built completely within the footprint of Level 1 of the pyramid, so *it was an Internal Ramp*, but with only open air above it, *it was also an External Ramp*.

This ramp was now used to haul stones to the top of Level 1, to build Level 2. When Level 2 was getting finished the Egyptians would once again only *leave out those stones* from level 2 that would *provide the space to extend the original ramp*, at the same 10 degrees slope, this time from the top of Level 1 to the top of Level 2. This longer ramp now reaching from the floor of the pyramid to the top of Level 2 would be used to haul stones to the top of Level 2, to build Level 3. At Level 3 again *only* those stones would *not be put into place* that would provide the footprint for the ramp to be extended from the top of Level 2 to the top of Level 3. This process would be repeated iteratively one layer at a time until the entire pyramid was completed. When the highest level was reached the ramp would look exactly like the road circling the stone mountain going round and around it till it gets to the top.

The difference between the road and the pyramid ramp is that the road was blasted out of the rock face in an L notch to build the road. The ramp on the pyramid, with the same L notch shape, was made by *first leaving out the stones to create the L notch* and then building the ramp to smoothly rise from one Level of stone blocks to the next higher one. Also, just like the road, the L notch was deeper and taller at the 90 degrees corners of the pyramid creating a broader ramp that curved smoothly around the pyramid corner from one flat face to the other to ease navigating even the largest and longest stone blocks around the corner without any trouble.

L Notch Ramp Dimensions

The above explanation has used, purely as a reasonable example, a 10 degrees ramp slope to calculate how long the ramp would be to rise to the height of 4.5 feet - the top of Level 1. The 10 degrees example clearly illustrates that a ramp with a reasonably easy slope to drag huge stones up did not have to be a huge ramp to move stones from one level the next. Building a 26 feet long ramp would be a trivial task for the Egyptians. At higher levels, as the stone heights became smaller, to as little as 1.5 feet (0.5 meter) (McKenzie 2016) at the highest levels, extending the ramp one level at a time would get increasingly easier at higher levels.

If instead of a ramp with a 10 degree slope we had used the example of a gentler ramp with an 8 degree slope the unfinished corner of level 1 would have been 10 feet wide and 32 feet long, to build the longer 32.5 feet ramp to reach the top of the 4.5 feet high level 1. Building a ramp of this length would be as easy as one of 26 feet in length for the Egyptians, demonstrating that the building technique is not dependent on the chosen ramp angle of the example.

Now let us address the width of the ramp. 10 feet has been used as a reasonable example of a ramp that should have been easily capable of accommodating the largest and longest stones used in the pyramid. Using the analogy of the road up the mountain think of 10 feet as one lane on a two-lane highway being used by a large truck pulling a 65 feet long trailer without a problem while driving within its designated 10 feet wide lane.

The largest stones in the Khufu pyramid are in and above Khufu's burial chamber. The largest stones are up to 25 feet long but in their smallest dimension (either their height or width) they are a maximum of 3-4 feet. Egyptologists commonly believe that the Egyptians used wooden sleds pulled by ropes (M. a. Lehner, Giza and the Pyramids: The Definitive History 2017), with probably water as lubricant between the sled base and the ramp, to move the stone blocks (Nicholson 2000). The sleds would have been of various sizes to accommodate the different sizes of stones used in the pyramid. Let us tackle the topic of the largest sleds carrying the very largest stones up the L Notch Ramp.

Let us use the example of a stone that is 25 feet long and 6 feet wide and 4 feet high. This is probably slightly larger than the largest stone used in the Khufu pyramid. This could be put atop a wooden sled that is 5 feet wide and 12 feet long. The stone would sit 6 feet high on the sled and would overhang the sled by 6.5 feet on either side of its length. Now think of the sled as a tiny 12 feet long car which is only 5 feet wide. Even the tiny Volkswagen Beetle car was 14 feet long and 6 feet wide. The beetle would have absolutely no problem going up the mountain road, in our example, and staying comfortably in its own 10 feet wide lane. When it came to the 90 degrees corner it would comfortably take the smoothly curving road to move from one flat face of the mountain to the other flat face of the mountain. The wooden sled being pulled slowly up the ramp would navigate the ramp and the 90 degrees corners with as much ease. The overhanging edges of the long stone might, at the pyramid corners, swing over the edge of the ramp, but this would be irrelevant since the 5 feet wide sled is always comfortably sitting within the normal 10 feet wide ramp. The safety margin is even greater at the corners because the deeper notch to accommodate the rounded ramp shape means the ramps at the pyramid corners are significantly broader than 10 feet.

This example clearly illustrates that the 10 feet L Notch Ramp width is a very generous example and the Egyptians might even have worked with narrower ramps of maybe 8 feet to haul even the largest stones to their required levels. We need to keep in mind that the Egyptians did not require this ramp width all the way up. At higher levels, as the stones got smaller, they would have used smaller, narrower, and lighter sleds requiring ramps of narrower width too. We will later review this in greater detail.

Is One L Notch Ramp Enough?

Let us now tackle the logistics of moving stones, sleds, and workers. Once the workers had moved their sled with the stone up to the level being worked upon, they would offload the stone which would be slid into its place. Now the workers had to take the empty sled and themselves down the pyramid levels to bring up the next stone.

It is proposed here that the Egyptians would have built a second ramp whose only purpose would be to serve as the passageway for descending sleds and workers. Here are the reasons why:

- A single ramp would have to be double the width, e.g., 20 feet to accommodate the ascending as well as the descending workers. The sheer chaos of two-way traffic and the danger this posed would have significantly impacted the speed and efficiency of the movement of stones and made the building of the pyramid in the designated timeframe an impossibility.

- A single ramp and its massive width would have posed significant challenges since it would take such a massive bite out of the pyramid face that putting all those stones back into place later would become an engineering challenge by itself.

- Separate Ascending and Descending Ramps would allow for an *efficient one-way flow* of ascending stone filled sleds pulled by workers and descending empty sleds and workers.

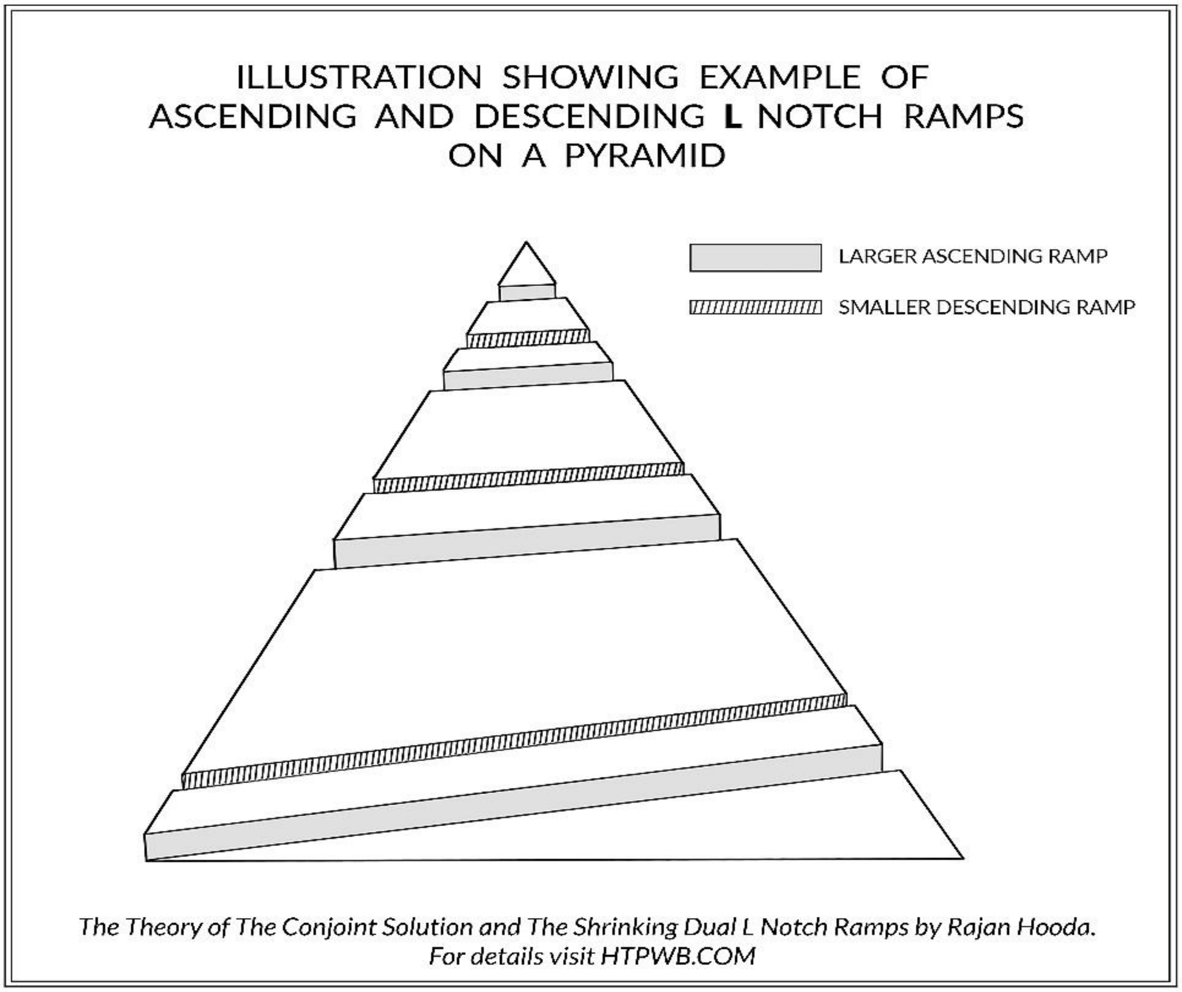
- The Descending L Notch Ramp would be much easier to build since it could be made narrower, e.g., 6 feet, since it only accommodates walking workers and empty sleds. Think of it as a 6 feet wide mountain hiking path. It would be easy and speedy to descend upon.

- Building a second dedicated Descending L Notch Ramp would also allow the Egyptians to build the main, Ascending L Notch Ramp with the minimum width necessary for safety, maybe even 8 feet, since they no longer needed to worry about descending traffic.

Another important consideration would be the placement of the second ramp in relation to the first. If the main ramp was built to spiral upwards in an anti-clockwise direction, then the second descending ramp would be started behind (to the left of it) and not too far away from it. This would be done for the following reasons:

- If the second descending ramp was to the left of the main ramp it would always, at their nearest distance, be *above* the main ramp. If something or someone fell from the descending ramp the falling object would likely not cause much damage to the main ramp below. If, however, something fell from the main ramp onto the descending ramp below the damage would be tremendous.

- The starting points of the two ramps would not be too far away from each other because the descending workers and the sleds would be needed at the staging area for workers, sleds, and stones, which would be positioned near the start of the ascending main ramp. Thus, the descending workers and Sleds would automatically arrive, upon descending, at the staging area to take the next load up the pyramid.



What Happened to The L Notch Ramps?

We now come to the most intriguingly fascinating and inspiringly elegant part of this jigsaw puzzle. Let us start at the penultimate level of the Pyramid, at Level 209. The Egyptians have now just completed the ramp from Level 208 rising 1.5 feet to level 209. They use the final section of the ramp to slide up the 4 sided and pointed capstone, waiting on the ramp at Level 208, and position it on the top of Level 209. The pyramid has now reached its final height. There are no more levels to build. The ascending ramp has reached its maximum height too.

The descending ramp was stopped several levels earlier since the square footprint of the final levels was too small to accommodate 2 ramps and the much smaller stones, that were being brought to these levels, were on such small sleds that the ascending ramp, by itself, was adequate to handle the 2-way traffic of ascending and descending workers and sleds. Further, the number of stones for the final levels were in such small numbers (the final Level 210 had only 1 stone) that using the one ascending ramp for the small amount of 2-way traffic involved was no problem at all.

Having placed the capstone in its position the Egyptians now removed the material used to create the small 1.5 feet high ramp from Level 208 to Level 209. Let us remember that the L Notch used to create the ramp was not blasted out of the pyramid like the L Notch in our road building example of the Stone Mountain. The L Notch was created by *not putting into place the stones that would have naturally been there had the L Notch and the ramp never existed!* The L Notch was created as *a result of incomplete construction.* With the ramp material removed the Egyptians just had to complete the construction of Level 209 by *putting the missing stone blocks and casing stones into their correct places*. They now repeated the process for Level 208.

Having now completed the Levels 209 and 208 the Egyptians now removed the ramp material connecting Level 207 to Level 208 and repeated the process described above to put into place the missing stone blocks and casing stones to complete level 207 also. There is one additional consideration. If some of the stones of Level 208 would have rested on the missing stones of Level 207 (e.g., maybe the casing stones of Level 208) then first the Egyptians would have to put into place the stones of Level 207 and then slid into place the stones of Level 208 (e.g., casing stones) that rested on top of Level 207.

Working in this manner, dismantling the ramp one level at a time and completing that level, and any level above it whose stones rested on that level, the Egyptians would work their way down, a level at a time, all the way to the bottom Level 1.

They would do the same again, starting from the top, for the second, smaller, descending L Notch Ramp.

The Khufu Pyramid would now stand complete! Since all the stones were now in place, *exactly where they would be if no ramp had ever existed*, there was *no evidence remaining that the ramps ever existed!*

The Shrinking L Notch Ramps

We now come to the reason why the Egyptians used significantly smaller stone blocks at the highest levels. While at the lowest level the stone blocks are 4.5 feet high at the highest levels, they are only 1.5 feet high (McKenzie 2016). It can be speculated that the Egyptians used smaller stones at the highest levels to make it easier to push up the stones to these greater heights. However, let us remember that the Egyptians did not make any design compromises *unless they were forced to do so.* These stone blocks were quarried far away, then precisely cut into shape, and then brought to the building site via boat and then dragged up to the construction site. The work to get these stones to the pyramid construction site required many times the magnitude of effort and manpower compared to the effort of pulling them up the ramp to the higher pyramid levels. Let us remember the Ancient Egyptians were perfectionists and had no shortage of labor so *any design compromise in the perfect symmetry of the pyramids was a forced choice*. Not having identical height levels at each level was a *very significant design compromise in the aspirational perfection of the pyramids*.

The reason why provides the remarkable proof of the method of construction.

As the pyramid levels got higher the size of the footprint of each higher level got smaller. The Egyptians realized that near the top the footprint size of the highest levels would *not accommodate* a 10 feet wide ramp. Let us take the example of a level near the top that is now only 20 feet by 20 feet wide on each of its square sides. If we had a 10 feet wide ramp encircling this level that level could not exist because the entire footprint would be used up for the ramp! This problem would even exist at lower levels where the footprint was larger, say even if it was 40 feet on each side, the wide encircling ramp would leave very little space at this level to build the next level up.

This problem has only one solution - the ramps had to be narrower to allow the smaller footprint highest levels to be built. This forced solution had a *remarkable knock-on effect* on the pyramid design. *The Egyptians were now forced to use smaller stone blocks that could be safely pushed up the narrower ramp necessitated at the higher levels.* In order to not look asymmetric, they were also now forced to gradually reduce the stone sizes of levels below so the transition from the large stone blocks used for the majority of the pyramid to the smallest stone blocks at the highest levels was a gradual transition, not an abrupt one, and an aesthetically pleasing one.

This remarkable forced design compromise, of gradually reducing stones for higher levels, provides direct proof of the L Notch Ramps technique for building the pyramids. None of the other existing theories of construction require this design compromise, while *for the L Notch Ramps it is an absolute necessity.*

Thus, the two parts, Shrinking L Notch Ramps and Smaller stones are two sides of the same coin - *a remarkable* ***Conjoint Solution*** *never recognized before!*

The method of construction of the giant pyramids is literally astoundingly *imprinted in its very design*, glaringly visible to the entire world - *its greatest secret so boldly hidden in plain sight!*

Implications of The Forced Design Compromise

First, let us briefly look at the skills needed to construct the pyramid. The forced design compromise would prove to have surprisingly significant implications here.

At the lowest skill level are the army of laborers probably using ropes tied to wooden sleds, loaded with the stones, to pull them up the ramps. These workers are relatively unskilled as their main contribution is their muscle power and stamina. There would have likely been no shortage of this labor pool since excavation of the worker's town, contrary to Herodotus' claims (M. a. Lehner, Giza and the Pyramids: The Definitive History 2017), showed they were well housed and well fed (Hawass 2006). Also, we need to realize that working on an 'eternal monument' for their 'Living God' was probably a source of honor and motivation for these workers and a role in great demand. The supply of such unskilled workers would have greatly exceeded the demand required for pyramid construction. *The laborers would not be a bottleneck in the timeline needed to construct the pyramid.*

The next higher level of skill requirement would probably have been wood craftsmen. They would build the sleds and probably more boats needed to carry the stones from the quarry down the river Nile to the Pyramid site. Wooden sleds and boats were already in great use to facilitate all the commerce and trade on the River Nile so their work would have been to initially increase the numbers needed and subsequently to only repair and replace aging equipment. Since wood was already being extensively used their numbers would also likely not have posed a challenge to the pyramid architects and would certainly not be a problem once the initial spurt of activity to build up the required capacity of sleds and boats was completed. As a result, *the wood craftsmen would also not be a bottleneck in the timeline needed to construct the pyramid.*

The next higher level of skill requirement would likely be the stone cutters at the quarries. They were working with much harder materials and their hardest metal tools were make of copper - not a very hard metal. They also worked with a variety of stone tools made of hard stone material like granite which could be used, along with the copper tools, to cut the limestone blocks from the quarry. The higher level of this skill, and the time required to reach these skill levels, would necessarily mean this pool of workers was *both scarce and valuable compared to the lower skill levels.*

As a result, the pool of stone cutters would likely have been a constraint and would be a determinant of the timeline to build the pyramid since this pool of workers would, *unlike the wood craftsmen,* be needed to work at full capacity *continuously during the entire time it would take to construct the pyramid*.

The highest skill level of workers that would be *continuously needed* during the *entire period of pyramid construction* would be the stone masons. These workers would work with the rough-hewn stone blocks given to them by the stone cutters. Their work would now include the following:

- Cut and grind the rough-hewn blocks into the exact shape and size of the stones needed for the particular level that was being constructed at that time. Remember the height and size of the stones was determined by the pyramid level.

- Once the shape was completed then they had to grind each of the 6 surfaces to a perfect flatness so that this stone would sit flush with its side neighbors as well as with the stone in the level below it and the future stone that would go above it at the next higher level.

- The corners had to be smoothed and polished to ensure a straight edge as well as a 90 degrees angle to ensure the minimal gaps that we see between stones in the great pyramid.

This work was painstaking, precise and required a high level of skill which would have taken years to develop. As a result, this pool of workers was also the scarcest and most valuable set of workers the pyramid architects needed. *Consequently, the stone masons were likely the greatest bottleneck and it was their speed and capacity for work that determined the time it would take to build the great pyramid.*

The architects of the pyramid would have taken every design step possible to ensure that this valuable pool of workers - the stone masons - *are not adversely impacted by any of their decisions* and instead that *their design decisions were made in a such a way as to optimize the use (i.e., lessen the work load) of this very valuable and scarce resource.*

Now we can turn to examining the implications of the forced design compromise on the two most valued and scarce pool of workers - the Stone Cutters and the Stone Masons.

Later, we will examine the implications for the pyramid architects.

1. Implications for Stone Cutters:

The stone cutters had to cut a six sided roughly hewn limestone block from the mountainside. Let us compare the rough stone dimensions of the stone blocks needed at the lowest level with the ones used at the highest levels.

At the lowest level the stone blocks were approximately 1.0 m x 2.5 m at the base with 1.5 m height. For the sake of our example below we will assume the stone at the lowest level was slightly smaller with 1.0 m x 2.0 m with 1.5 m height.

At the highest level the blocks were 1.0 m x 1.0 m with 0.5 m height. Here m stands for meter.

Let us assume that a stone cutter has cut a stone block for the lowest level matching the needed dimensions of 1.0 m x 2.0 m x 1.5 m. To do this he had to make 6 cuts - one cut for each face of the stone block.

Now assume that the architects decided that no more large stone blocks were needed and the stone cutter should instead make smaller stone blocks needed for the highest levels.

To do this the stone cutter would imagine this large 1.5 m high stone block as a three-layer cake - each layer with a height of 0.5 m. He would then make two horizontal cuts to separate each layer. The first horizontal cut would be made 0.5 m from the top surface and the second horizontal cut would be made 1.0 m from the top surface. Now he would have 3 separate, horizontal stone layers of 0.5 m height each, stacked one on top of the other to reach the 1.5 m height of the original single block.

Next, he would make a single vertical cut in the middle of the 2.0 m wide stacked stone blocs to get 6 smaller stone blocks each 1.0 m wide and 0.5 m high. These 6 stone blocks are now the exact dimensions needed for the highest levels.

We need to remember that the blocks of stones were used to fill up a space that took the shape of the pyramid. The one large stone block would have served to fill up the same amount of space as the 6 smaller stone blocks in the above example. So, *there is no advantage to the 6 blocks versus the one block* in terms of how much material is needed to fill up the pyramid. The two are *exactly equivalent in the amount of material they provide to fill up the pyramid.*

However, *the amount of work to cut 6 blocks is significantly more than to create the one larger stone block.*

The larger stone block needed 6 cuts to make, one for each side. Since all these sides are also shared with the smaller stone blocks these 6 cuts would also be needed *even if the stone cutter had directly started with the objective of cutting 6 smaller stone blocks from the mountainside.*

However, in addition to these original 6 cuts the stone cutter had to make 2 additional horizontal cuts to reach the height of 0.5 m and one additional vertical cut to reach a width of 1.0 m.

This makes a total of 9 cuts to create 6 smaller stones compared to 6 cuts to create one stone block *each of which would provide an equivalent amount of material to fill the pyramid*.

When compared to the work needed to cut the stones at the lowest level, the decision to switch to the smaller stones at the highest level *would increase the workload of the scarce, valuable pool of stone cutters by an astonishing 50%.*

Given this dramatic adverse impact on the productivity of the stone cutters, the decision by the pyramid architects to use the smaller stone blocks was clearly a very difficult decision and *not one made willingly.*

2. Implications for Stone Masons:

Now let us turn to the stone masons. Remember that they need to reduce each of the stone's 6 surfaces to their final dimensions and then work on each surface to completely flatten it and smoothen the surface so all surfaces sit flush with the surfaces of adjoining stones.

The large stone block for the lowest level has 6 surfaces for the stone mason to work on. Let us assume that the stone mason has finished working on all 6 surfaces before the decision is made to recut this block into the 6 smaller stone blocks. Now the stone cutter makes his 2 horizontal cuts and the one vertical cut described above to create the 6 smaller stone blocks from this one large block. Notice that the work the stone mason had already done in finishing the 6 surfaces of the large stone block does not go to waste as all those finished surfaces will become *part of the finished surfaces of the 6 newly cut smaller stone blocks*. So, this work *would have to be done anyway even if the stone mason had started directly with 6 rough-hewn small stone blocks.*

However, the stone mason's work for the 6 smaller stone blocks is not finished yet. Let us go back to the example. Now the stone cutter has made the 2 horizontal cuts and the one vertical cut in the large stone that had been completely finished by the stone mason. When the first upper 0.5 m layer of stone is removed *the one horizontal cut* will *reveal 2 unfinished surfaces.* The *bottom of the first layer is* *unfinished* as well as *the top of the second layer is also unfinished*. The same will happen with the second horizontal cut as well as the one vertical cut.

The nature of making a cut is such that a single cut creates 2 surfaces. The stone mason will now have to work to finish and smoothen out each of these 2 surfaces. Since the stone cutter needs to make 3 cuts the stone mason will have an additional 6 surfaces to work upon.

Since the original large stone block required the stone mason to work on 6 surfaces the smaller stone blocks will increase his work load to 12 surfaces - *a staggering 100% increase in the workload of the scarcest, most valuable skilled pool of workers whose capacity is the bottleneck to the speed of construction and thus determines the time it would take to complete the pyramid!*

3. Implications for Pyramid Architects:

As we can now see the forced design choice had a drastically delaying effect on the time it took to construct the pyramid. The Egyptians architects made this decision despite the fact that this choice significantly increased the greatest risk in building this pyramid - that the Pharaoh might die before it was completed. *That the architects of the pyramids made this dramatic decision points to the fact that they had no other choice*.

The forced design choice of smaller stones necessitated by the need for shrinking narrower ramps were both necessary conditions without which the highest levels of the pyramids could not possibly get built. The Shrinking L Notch Ramps and the smaller stones are two sides of the same coin – a remarkable ***Conjoint Solution***. However, now understanding the massive risk and delay this choice posed to the Egyptian architects we now also know that this was not just the way the pyramid was built - but even the Egyptian architects knew and accepted that this was the ***only effective way*** this pyramid ***could be built.*** This dramatically significant forced design compromise and its drastically adverse implications ***provide the most compelling, irrefutable evidence of both the Conjoint Solution and the use of the Shrinking L Notch Ramps methodology.***

All the pieces of this magnificent puzzle are now in place.

Why Did It Take 4500 Years To Figure This Out?

It appears that *this is the only way the gargantuan pyramids* **could** *have been built!* The incredible Egyptians figured this out more than 4500 years ago and yet it has stumped all of humanity since then! *Therein lies the true and incomparable genius of the Ancient Egyptians!*

The true beauty of this construction methodology lies in the combination of its many unique and remarkable features, ***which in its totality provide the irrefutable evidence of this methodology of construction for the pyramids***. Consider this:

- **Remarkable Efficiency:** This method requires *no additional construction* effort outside the footprint of the pyramid itself, making it the most efficient method possible to construct the pyramid.

- **Genius Simplicity:** This method requires *only the knowledge of building simple ramps*. The L Notch Ramps were extended one level at a time, 208 times. However, each section was small and easy to build. The largest section was the first one, approximately 26 feet in length, around 10 feet wide and rising only to a maximum height of around 4.5 feet. The ramp sections became smaller at higher levels with the topmost ramp sections each rising to only a height of 1.5 feet.

- **Elegant Logistics:** The use of *separate L Notch Ramps for ascending and descending* would have created a one-way, smooth, seamless, and very efficient methodology to keep the stones moving up and the empty sleds and returning workers coming down. It was almost as if they *created the first human powered Conveyor Belt* for the movement of huge stone blocks.

- **Uniquely Innovative Interior-Exterior Dual L Notch Ramps:** By conceiving of and developing a unique new type of ramp the Ancient Egyptians created a solution that *had the advantages of both the interior as well as exterior ramps* (efficiency and simplicity respectively) but, amazingly, *had none of the disadvantages of either interior or exterior ramps* (complexity and size respectively).

- **Methodological Invisibility:** This method cleverly *leaves no evidence if its methodology*. This is one reason the mystery of its construction was unsolved for several millennia. Archaeologists have spent ages looking for evidence of the construction methodology. As a result, they may *not have considered the possibility* that the *methodology used could be one that leaves no evidence of its use*!

- **Fully Visible Slope Angle and Pyramid Face:** The L Notch Ramps allow the pyramid architects full visibility of the pyramid slope and pyramid face since no external structure blocked either. This was critical to allow the constant measurement of both to ensure that the pyramid angle was maintained and that the pyramid face remained straight and flat.

- **Shrinking L Notch Ramps:** This method *uniquely identifies the construction challenge* posed by the highest levels of the pyramid due to the *shrinking footprint of the higher levels*. It also *identifies the only **Conjoint Solution** to this problem - Shrinking L Notch Ramps **and** smaller size stones.*

- **Significant Design Compromises:** This method also *uniquely explains why the Ancient Egyptians, who were perfectionists, made the design compromises of using different sizes of stones* - larger at the bottom and smaller at the higher levels. It shows how this component of the '*Conjoint Solution*' caused significant delays in the building of the pyramid due to the dramatically increased work load on the most scarce, most skilled workers that this design compromise imposed. *This in turn provides the irrefutable evidence that the Conjoint Solution and use of Shrinking Dual L Notch Ramps is how the pyramid was built.*

- **Incomplete Problem definition:** By focusing primarily on how the pyramids were built past researchers probably never probed deeply enough into the question of why the design of shrinking higher levels in the pyramid was the way it is - and *if the design feature itself could provide a clue to the puzzle*. Further, the design was *never recognized as a major forced compromise*. Finally, the full implications of such a forced compromise, and its significantly adverse impact on the work load, especially for the most scarce, most skilled workers, and the resultant delay in the timeline to build the pyramid which created the great risk of not finishing it before the demise of the Pharaoh; *all have never been recognized.* If past researchers *never recognized the complete puzzle,* in attempting to solve *only part* *of the puzzle, the complete puzzle of the pyramid's construction, as a result,* ***became unsolvable***.

These 9 reasons outlined above demonstrate the *immensely convoluted and interconnected complexities* of this great puzzle and highlight why it remained unsolved for the last 4500 years!

The Theory of The Conjoint Solution and The Shrinking Dual L Notch Ramps

These 9 reasons also form the interlocking components that create the integrated solution of this immensely complex 3-dimensional puzzle. The solution *cannot come together from a subset of these components*. All 9 of these are needed to fit together symbiotically to ***provide irrefutable proof of the Fully Integrated Solution*** of how the pyramid was built - *through the comprehensive development of* ***The Theory of The Conjoint Solution and The Shrinking Dual L Notch Ramps.***

Conclusion

The great pyramids have always been a source of awe-inspiring wonder and beauty. The puzzle of their construction only added to their remarkable mystique. However, even if we now understand how they were built, this does not in any way diminish their spectacular magnificence. On the contrary, knowing how the builders conjured up this remarkable methodology for its construction, and conceived of ***The Conjoint Solution and The Shrinking Dual L Notch Ramps***, only increases the wonderment we should feel for the sheer genius and remarkable audacity of the Ancient Egyptians. 4500 years ago, they figured out how to construct such a gargantuan edifice to their greatness - something that all of subsequent Humanity could not figure out!

All Hail the Ancient Egyptians!

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Addendum:

This addendum within the boxed text has been added by the author in May 2026 to the research paper above - which remains in its original form - unchanged in its entirety.

‘I have recently been made aware of a published paper from 1998 written by Rosemarie Klemm and Dietrich D. Klemm which I was unaware of primarily because it was written in the German Language. This paper provides the first known basic idea of a ramp built into the face of the pyramid – which the authors call an ‘Integralrampe’. Egyptologists quicky pointed out several major drawbacks with this early model which is why it never gained traction. However, due to its precedence in suggesting such an approach it is now included here as a notable reference.’

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