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Hemienu to Houdin: Phase Two, Part A—The King's Chamber of the Great Pyramid

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Jean-Pierre Houdin's theory of how the Great Pyramid of Khufu was built is unique not only in that he explains how this engineering marvel was accomplished, he shows how the architecture itself gives up these secrets. Nowhere is this more evident than in his explanation of how the Grand Gallery served as the mechanism for constructing the King's Chamber.

The burial room of Pharaoh Khufu required that his Overseer of Royal Projects, the great architect and engineer Hemienu, transport massive beams of granite, some of which weighed in excess of 60 tons, more than 60 meters above the pyramid's foundation. With each successive course of blocks his workspace became more confined, the uphill drag became longer, and the placement became more precise. Where did the energy required for this undertaking come from?

In Phase One we looked at how two thirds of the pyramid and all of its internal structures below the King's Chamber were constructed with a ramp that reached less than one third of its height. In Phase Two we will look at how the King's Chamber and its related architecture were built using this same ramp, as well as some innovations in design and methodology that included scaffolding, an elevator, and a powerful tractor, all of which were integrated into the architecture itself, and all of which used tools and principles known to be in existence during Hemienu's time.

We will devote this current article to explaining exactly what it was Hemienu was building in Phase Two.

Intro

During Phase Two Hemienu was entirely concerned with the construction of the King's Chamber, and perhaps it is best to forget for the moment about the rest of the pyramid. The Great Pyramid at that point was a massive 43 meter high platform that provided both the foundation for and the machinery involved in building a smaller pyramid, which in turn served the dual purpose of support and scaffolding for the burial chamber and its related architecture. In Phase Two, the superstructure we will be referring to is not the Great Pyramid itself, but this mini-pyramid being constructed on its fiftieth course.

But we will also be taking a much more detailed look at the Grand Gallery and its related architecture. If the Great Pyramid was a machine of construction during Phase Two, then the Grand Gallery and the Ascending Corridor housed its engine. Phase One was a saga of architecture, geometry, and logistics. Phase Two is a tale of men and machines—elevators, counterweights, ballasts, even trolley tracks. And yes, ramps.

The megalithic beams that comprise the King's Chamber and the Relieving Chambers were first pulled up the external ramp and stored on a reinforced staging area. This was accomplished with the help of a counterweight system in the Grand Gallery. Then a mini-pyramid was built as the King's Chamber went up. This structure served as both the support for the King's Chamber architecture and the scaffolding for

the project. A freight elevator, also powered by the counterweight system, was incorporated into this mini-pyramid, all of which would disappear into the core of the Great Pyramid in Phase Three.

Like Phase One, Phase Two can be divided into three sections—the worksite formed by the fiftieth course of the pyramid and how the external ramp functioned during this phase, how the counterweight system worked, and then finally the King's Chamber. But in order to fully appreciate how the worksite was organized, how the mini-pyramid was constructed, and how the counterweight system worked, it is best to start with a detailed description of the King's Chamber and its related architecture.

Hemienu to Houdin Phase Two will thus be divided along these lines: Part A—The King's Chamber; Part B—The Grand Gallery and Counterweight System; and Part C—How It All Came Together.

The King's Chamber… Or *is* it? Discounting the Unlikely Emperor's Chamber

Arguments to the contrary notwithstanding, as far as we know the King's Chamber was intended to be Pharaoh Khufu's final resting place, which (obviously) is why it is called *the King's Chamber*. While there are those who believe that Khufu's actual burial room lies yet undiscovered within the Great Pyramid, there is some fairly good circumstantial evidence that the King's Chamber was intended to be the focal piece of the whole ensemble. To begin with, it contains a sarcophagus... generally considered a pretty reliable clue that a room might be a burial chamber.

[*Anecdotal Exception*: I once knew a police detective who kept a coffin in his living room. When I asked him why, he said because the neighbors complained about it being on his porch. True story.]

But there are other reasons as well. Structurally speaking, it is the center of the design. This does not mean that it is literally in the physical center of the pyramid. Instead, it means that everything below, beneath, and around the King's Chamber was designed to support a 20x10 cubit room *with a flat ceiling*, exactly where it is located. Everything else, from the materials used in its construction to its exact positioning, was geared toward achieving this goal. Hemienu would accomplish this using tried and true methods and innovations that expanded on these techniques.

As we will see throughout our explication of Phase Two, the Grand Gallery exists *as it does* and *where it does* in order to build the King's Chamber. When compared with the external ramp and the elevation of the Relieving Chambers, every detail from the length and height of the Grand Gallery to the positioning of the Great Step was determined by the dimensions of the King's Chamber and the gabled ceiling of the structure above it. So if there is an even *more* regal tomb in the pyramid—we'll call it the *Emperor's Chamber*—then where is it and how was it built?

One possibility is that it could be to the south of the Queen's Chamber, but again, where? In order to stay on the north/south axis it would have to be lower than the southern "air shafts" (intercom channels) leading out of the King's and Queen's chambers, which would situate it lower than both, which is not a very stately location for an Emperor. Royal burial chambers in the large-scale pyramids prior to Khufu (Djoser's Step Pyramid is an exception, but a lot of changes followed Djoser) were higher than other chambers and antechambers, and Khafre would likewise follow suit.

At this point a skeptic might point out that Pharaoh Menkaure, who came after Khafre, located his final burial chamber lower than an earlier burial room. Both of these tombs were cut into the bedrock, which could explain the deviation. While it is true that changes in a pyramid that is already under construction are risky, one safe place to make changes is in the bedrock. Unlike a pyramid, which becomes smaller as it rises, making alterations difficult, changing the layout of the understructure in the bedrock was comparatively simple and safe.

The point being that when construction is progressing downward, as it would be in the bedrock, rather than upward, as it would be in the superstructure, Menkaure could feasibly have decided to make an even more impressive burial room deeper than the other chamber. I am not arguing that this is the "exception that proves the rule," but I *am* saying that once the pyramid was underway the only safe place to make a large change in plan was deeper into the ground (parallel excavation would have undermined more of the superstructure), and the promise of a better tomb may have outweighed tradition.

Nothing discovered so far suggests that a larger, more impressive burial chamber was excavated in the bedrock beneath the Great Pyramid, and there is no evidence of a larger tomb in the superstructure beneath the King's Chamber. There is evidence of additional plans in the Subterranean Chamber, such as the so-called well-shaft and the southern extension, but whatever their intended purpose may have been, they were abandoned, most likely when the Queen's Chamber was completed and there was no longer a use for the chamber as a provisional tomb.

Although Menkaure's pyramid shows that tradition is not always a hard and fast rule, it does not seem likely that Khufu would have settled for a burial chamber that was both lower and smaller than the King's Chamber. The man who commissioned the only surviving Wonder of the Ancient World does not strike me as a man prone to compromises. So what about *beside* or *above* the King's Chamber?

It is not likely that an Emperor's Chamber could exist *parallel* to the King's Chamber because if it were centered along the north-south axis (as everything else is) then one or both of the southern intercom channels would pass through it. This same problem exists for several meters higher than the floor-level of the King's Chamber. In fact, an Emperor's Chamber would have to be higher than the gabled ceiling of the Relieving Chambers; otherwise the rafters would be directing the pressure from the masonry into the hollow space of the Emperor's Chamber, leading to a collapse of both.

Building an Emperor's Chamber *above* the rafters brings us back to the problems of Phase One—how do you deliver the megalithic beams that high? Building a higher room would require another set of Relieving Chambers for a flat ceiling, or at least another set of rafters if it had a gabled ceiling. Recall that Hemienu went to great lengths to avoid corbelling everywhere but the Grand Gallery, and both a flat and gabled ceiling would require the transport of beams that would be too large for the internal ramp, requiring a longer and higher external ramp, a problem we already examined at length.

Building an Emperor's Chamber—a burial room at least as impressive as the King's Chamber, only higher—would not only have required a bigger external ramp, it would have required a second counterweight system, which means *a second Grand Gallery* and *a second Ascending Passage*way are likewise hidden somewhere in the considerably more restricted space of the top half of the Great Pyramid. Otherwise there would be no way to raise the massive beams required for its construction. A cursory glance at the inner workings of Khufu's Pyramid in profile shows the impossibility of this.

So to return to the question, *was the King's Chamber intended as the final resting place for Pharaoh Khufu, or is there an even better Emperor's Chamber that lies undiscovered*, the answer seems to be the former: the room that contains the sarcophagus was indeed the king's burial room. The Emperor, it would seem, has neither clothes nor a tomb.

But in the final analysis, the question is largely academic. If a secret room containing Khufu's mummy is discovered tomorrow it will have no bearing on the question of how the King's Chamber was built. It may offer new questions and potentially a few answers, but it would not change a single aspect of what we do know about the King's Chamber and its architecture, and what was required in its construction. So let's

take a look at what we do know for certain—dimensions and materials. We will start with what is inside the King's Chamber—the sarcophagus.

The Sarcophagus of Pharaoh Khufu

Just as the King's Chamber is the focal point of the Great Pyramid, the sarcophagus is the focal point of the King's Chamber. And likewise, just as the King's Chamber is not the physical center of the pyramid, the sarcophagus is not in the physical center of the King's Chamber—both are precisely aligned, but with a larger scheme in mind. The sarcophagus is oriented north to south close to the west wall of the burial room, with the eastern side of the sarcophagus situated along the north-south axis of the pyramid.

The sarcophagus was meticulously hollowed out from a single block of red Aswan granite. Spiral markings inside the box and pinion holes on the western lip indicate the use of drills. We know that copper tubular bow-drills were used during this period, and the markings suggest drills and saws were used for precision and dolerite pounders to wear away the bulk. Rather than teeth, the copper tools would have used an abrasive grit to cut, much like sand paper. It would have been a long and tedious process, taking no less than 28,000 hours to complete (Brier and Houdin, pp. 199-200; Stocks, pp. 918-22).

The sarcophagus measures 2.28 meters long, .98 meters wide, and 1.05 meters in height. The inner dimensions are 1.98 meters long, .67 meters wide, and .87 meters deep, and it weighs around 3.75 tons. It is a simple box with no ornamentation or markings. There is no lid, although the pinion holes and an inner groove on the upper edges suggest it was fitted for one. Where the lid is now is anybody's guess. It is estimated that it would have weighed around two tons and is an unlikely object for theft, but never underestimate the determination of souvenir takers.

The southeastern corner of the sarcophagus has been broken away, which may have been done by thieves who either used the hole to reach inside and grab the treasures within, or may have provided a leverage point for prying the lid off. But analysis of the breakage is made difficult by the fact that visitors (vandals) have chipped away at it over the years in order to have their own little piece. For some, nothing says veneration like wanton destruction. Perhaps the lid suffered a similar fate?

The sarcophagus is too large to fit through the entrance to the King's Chamber, and so it would have been installed during construction. No mummy was discovered in the sarcophagus, which adds to speculation about the purpose of the King's Chamber (not to mention the pyramid itself) and about the existence of an undiscovered Emperor's Chamber. Khufu's mummy either remains interred, was misplaced or destroyed, or lies unidentified in a museum or private collection. Or he could be propped up in a curio show next to a stuffed two-headed calf… believe it or not, there is precedence.

The King's Chamber

The King's Chamber measures 20 cubits (10.47m) east to west and 10 cubits (5.23m) north to south. It has a flat ceiling that is a little over 11 cubits (5.84m) above the floor. The floor, walls, and ceiling are all constructed out of the same red granite as the sarcophagus. This granite is much heavier and sturdier than the nummulitic limestone that comprises the bulk of the pyramid, and served both visual and structural purposes. The floor and walls are made of around 120 granite blocks of various sizes, and the ceiling is made of nine granite beams.

The ceiling is significant in a couple of ways. For one, it is located at one third the vertical height of the Great Pyramid, which may have been for both structural and symbolic reasons. Second, and more

importantly, it is flat. This is unusual in that other pyramid burial chambers are either corbelled or, in the case of the Queen's Chamber, have a gabled ceiling.

Corbelling is a roof-building strategy that involves inching each layer of blocks slightly inward until the walls come to a peak. Long blocks of limestone are too weak to span wide spaces, so corbelling bridged these gaps a little at a time, with most of the block sandwiched between the layers above and below and only a small part extended into unsupported space. The main burial chamber of the Red Pyramid is a classic example.

Corbelling also distributes the weight above the chamber over a wider space. In a flat ceiling all of the weight bears straight down over the entire surface. This means that even using a more sturdy material than limestone would not be enough to construct Khufu's flat ceiling, there had to be a way to distribute the pressure outward and away from the ceiling, which is where the Relieving Chambers come in.

The Relieving Chambers

The Relieving Chambers are five short chambers stacked one on top of the other between the King's Chamber ceiling and the top gable. Like the King's Chamber itself, the ceilings of the Relieving Chambers were made of the megalithic beams of granite supported by limestone blocks. The granite ceiling beams, each weighing between 27 and 63 tons, are arranged side by side at each level, north to south, and the limestone supports are arranged east to west between the ceilings. The granite beams are finished on the bottoms (the compartment ceilings) but left rough on the top (the floors).

In all, there are five granite ceilings: the King's Chamber located at the 48.8 meter level; the first Relieving Chamber ceiling at 51.9 meters; the second Relieving Chamber ceiling at 54.6 meters; the third Relieving Chamber ceiling at 57.5 meters; the fourth Relieving Chamber ceiling at 60 meters. Above this are the 22 limestone rafters that form the gabled roof. Total materials for the Relieving Chambers: 43 granite beams weighing 27-63 tons each, 22 limestone rafters weighing 28-45 tons each, and the limestone supports between the ceiling layers.

The gabled ceiling of the Relieving Chambers provides further clues to Hemienu's planning and foresight. Before the Great Pyramid, the Red Pyramid of Snefru represented the crowning accomplishment in pyramid technology. Hemienu knew that the ceiling of Snefru's corbelled burial chamber successfully supported 83 meters of masonry above it. We know by comparing other examples that the distance between the floor of the King's Chamber and the gabled roof is about the same as it would have been if it had been corbelled, and the gabled roof, like the Red Pyramid, supports about 83 meters of masonry. Again, methods tried and true.

The relieving Chambers are the only place within the Great Pyramid where any sort of markings or inscriptions have been found, and even these appear to have been quarry markings or "graffiti" left by the pyramid builders. Two of these markings are cartouches of Pharaoh Khufu, the only actual written evidence that the Great Pyramid was build for him. Some of the markings clearly continue along surfaces now covered by other blocks, evidence that these inscriptions occurred before the construction was complete.

This completes our description of the King's Chamber, its only contents, and the Relieving Chambers above it. In ***Phase 2, Part B: The Grand Gallery and Counterweight System***, we will look at Jean-Pierre Houdin's theory of how the Grand Gallery once housed a counterweight system that helped power the huge sleds that brought the megalithic beams up to the 43 meter-high worksite, and the lift that delivered them to their final locations in the architecture.

Works Cited:

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