CHAPTER 7

The Three Large Pyramids of King Sneferu

Before entering the main discussion, I would like to outline the reign lengths of the kings of the Fourth Dynasty.
In the Old Kingdom, the reign lengths of individual kings often differ by several decades depending on the scholar, and they are not firmly established.

For example, The Book of Ancient Egypt published by the British Museum lists explicit reign dates only from the Eleventh Dynasty onward, and does not provide reign dates for the Old Kingdom.

In contrast, The Oxford History of Ancient Egypt, edited by Ian Shaw, includes reign lengths for each king, and many publications adopt these figures as their standard.

American publications, however, often rely on Atlas of Ancient Egypt by Professor John Baines and Jaromír Málek, and these figures appear in works by Mark Lehner and Richard Wilkinson.

Table 7-1. Reign Lengths of the Fourth Dynasty Kings

King	British Tradition	Years	American Tradition	Years
Sneferu	2613–2589	24	2575–2551	24
Khufu	2589–2566	23	2551–2528	23
Djedefre	2566–2558	8	2528–2520	8
Khafre	2558–2532	26	2520–2494	26
Menkaure	2532–2503	29	2490–2472	18
Shepseskaf	2503–2498	5	2472–2467	5

Even in the United States, the Metropolitan Museum of Art does not specify reign dates for Old Kingdom kings.

A comparison of the two systems is shown in Table 7-1.

Although the absolute dates differ by 38 years, the reign lengths of Sneferu, Khufu, Djedefre, and Khafre are identical in both traditions.

Only Menkaure shows a discrepancy of eleven years.

In this book, I adopt the British chronology for convenience, but the absolute dating differences themselves are not the subject of discussion.

Other proposals exist, such as Tallet's suggestion that Khufu reigned for 27 years.

Regarding Sneferu, Rainer Stadelmann proposed a reign of 48 years based on numbers written on core stones of the Red Pyramid (Beiträge zur Geschichte des Alten Reiches, MDAIK 43, 1987).

Stadelmann argued that since Sneferu built three large pyramids, his reign must have been longer than 24 years.

However, this book does not adopt such reasoning.

Rather than assuming a longer reign simply because construction seems difficult within 24 years, I examine in Section 4 what methods might have made the construction feasible within the commonly accepted reign length.

1. The Step Pyramid at Meidum

King Sneferu, founder of the Fourth Dynasty, is known for having built numerous pyramids.

He constructed three large pyramids and several smaller ones at sites such as Fayum and Edfu.

The pyramid at Meidum, originally built as a step pyramid, retains sloping remnants at its lower portion.

It was surveyed in the late nineteenth century by Flinders Petrie, who published Medum in 1892.

Petrie recorded the base length as 5,682 inches (approximately 144 m), and noted that the original step pyramid had been converted into a true

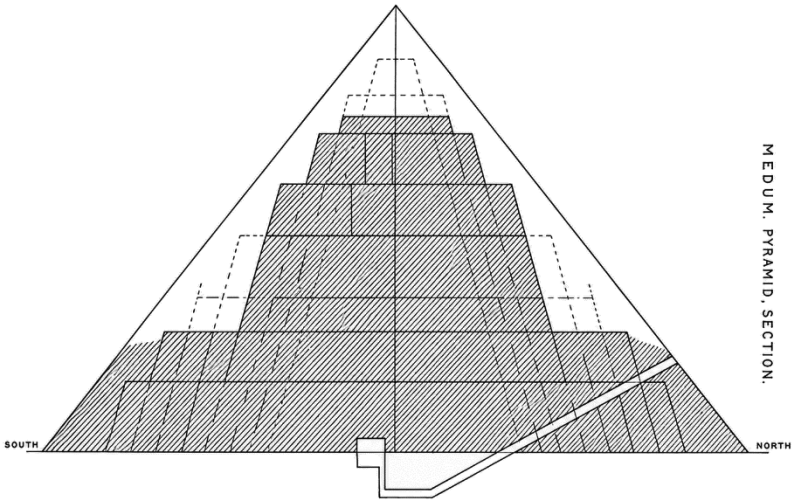

Fig. 7-1. The True Pyramid at Meidum (traced from Petrie's reconstruction drawing)

pyramid by adding limestone casing stones.

His report includes a reconstruction drawing of this form.

Earlier scholarship held that the step pyramid portion was built by King Huni (the last king of the Third Dynasty), and that Sneferu later converted it into a true pyramid.

However, recent studies increasingly support the view that Sneferu built the entire structure from the beginning.

Although the casing stones have collapsed, Petrie's drawings indicate an outer slope of 51.5 degrees.

The text of Medum also states that the slopes of various sections were around 51.5 degrees.

With a base of 144 m, the height would have been approximately 90 m.

Menkaure's pyramid has a base of 104 m and a height of 66 m, with a slope of 51.3 degrees.

Its appearance is similar, but the Meidum pyramid is significantly larger.

Stadelmann argued that the conversion into a true pyramid occurred

in the latter half of Sneferu's reign, after the Bent Pyramid.

However, this overlaps with the construction period of the Red Pyramid, making his claim doubtful.

Following Kurt Mendelssohn's reasoning, it is also possible that the Meidum pyramid began to collapse, prompting a shift to Dahshur.
For these reasons, I consider Meidum to have been the first true pyramid.

Thus, the origin of the large Fourth Dynasty pyramids lies in the step pyramid at Meidum.

When this step pyramid was converted into a true pyramid, it is significant that a construction method fundamentally different from the step-pyramid techniques of the Third Dynasty was devised. As explained in detail in Chapter 5, the scaffolding and ramp system used for true pyramids does not lie on a simple extension of the ramp concepts employed for step pyramids.

2. The Significance of the "Bend" in the Bent Pyramid at Dahshur

The next large pyramid built by King Sneferu is the so-called Bent Pyramid at Dahshur, well known for its distinctive shape.

Since this pyramid was conceived as a true pyramid from the outset, it is reasonable to assume that its construction began around the same time as the conversion of the Meidum pyramid from a step pyramid into a true pyramid.

Meidum and Dahshur are separated by roughly 40 kilometers in a straight line, which in ancient terms would have been perceived as entirely different locations.

Thus, it is not surprising that the two projects may have proceeded independently.

Alternatively, as Kurt Mendelssohn suggested, construction at Dahshur may have begun after the Meidum pyramid started to collapse.

The lower portion of the Bent Pyramid has a slope of 54 degrees, while the upper portion has a gentler slope of 43 degrees.

This change in angle was made during construction.

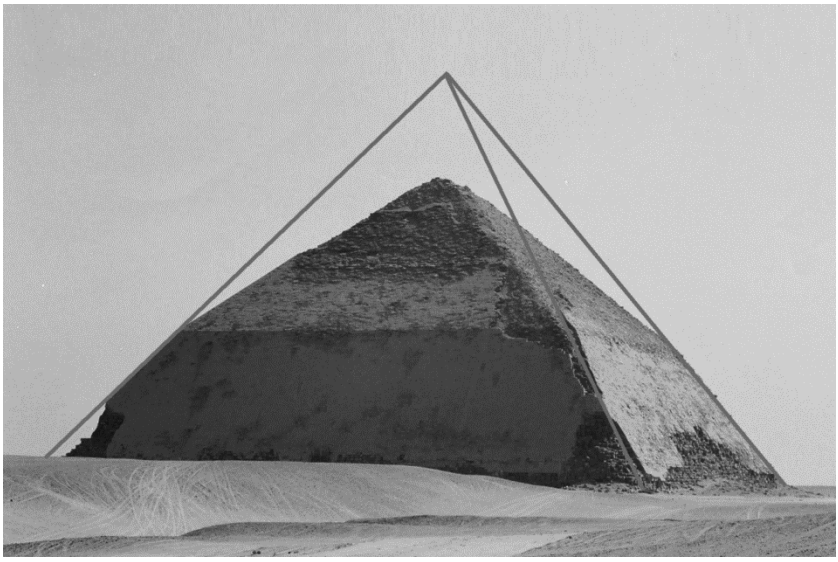

Fig. 7-2. The Bent Pyramid at Dahshur (photograph and virtual reconstruction by the author)

In technical terms, it represents a "specification change," implemented because structural instability—such as deformation and cracking—had begun to appear, indicating an impending collapse.

Although symbolic or religious interpretations have been proposed, such as those by Alexander Varille, traces of structural countermeasures inside the pyramid support the view that the angle was altered to prevent collapse.

This book adopts that interpretation as the working assumption.

Extending the lower ridge line upward reveals the original design intent of the Bent Pyramid.

Its present height is 101 meters, but if the 54-degree slope had been maintained, the height would have reached 130 meters—second only to Khufu's pyramid.

Because a pyramid is a square-based pyramid structure, the load borne by the central portion of the base directly beneath the apex is greatest.

Table 7-2. A Technical Comparison of Horizontal and Inward-Leaning Masonry Techniques in Pyramid Construction

Item	Horizontal Courses	Inward-Leaning Courses
Initial direction of forces	Downward	Downward plus inward toward the center
Condition of the central core	Mostly stable under vertical load	Vertical load combined with concentrated inward forces from surrounding blocks
Behavior when upper loads increase and deformation begins	Deformation spreads gradually outward	Ground pressure rises beyond the original vertical load due to inward horizontal forces
Collapse risk	Detachment of casing stones	Failure of the central structural core

As height increases, this load intensifies, producing deformation pressure.

Thus, the most fundamental countermeasure is to reduce the height by altering the slope.

What deserves particular attention is the decision-making process that led to adopting the gentler slope.

Not only was the angle changed, but the masonry technique was also altered: the lower portion was built using inward-leaning courses (accreted layers), whereas from the bend upward, the builders switched to horizontal courses.

Inward-leaning masonry was a well-established technique known to produce a tightening effect toward the center, thereby strengthening the structure.

However, while effective in preventing the detachment of casing stones, this method increases inward horizontal forces as the pyramid

grows taller.

These forces become enormous, exerting intense pressure on the central core.

With no path for this pressure to dissipate, it translates into increased vertical load, concentrating ground pressure beneath the center of the pyramid and causing subsidence.

Horizontal masonry, by contrast, directs forces primarily downward, reducing excessive load concentration at the center.

Given these technical considerations, the builders reduced the slope from 54 to 43 degrees and adopted the conservative but rational method of horizontal masonry to limit excessive central loading and continue construction safely.

This change strongly suggests that expert technical advice was sought and accepted.

From a project-management perspective, this represents a major shift. A royal construction project—executed according to the will of the king—encountered a structural crisis, and in response, the builders adopted expert recommendations and implemented a bold modification.

The "bend" of the Bent Pyramid thus stands not only as evidence of a structural specification change but also as a sign of a transformation in management style: a willingness to incorporate specialist advice.

3. Technical Continuity and Safety Measures Leading to the Red Pyramid

Although the Bent Pyramid was completed by reducing the upper slope angle, thereby avoiding abandonment or collapse, its unusual appearance was likely unsatisfactory to the king and the ruling elite.

Following its completion, construction of the Red Pyramid began.

The upper slope of the Bent Pyramid is 43 degrees, and the Red Pyramid was built with exactly the same slope.

This indicates that the technical guidelines (specifications) adopted during the "bend" were strictly carried forward into the next project.



Fig. 7-3. The Red Pyramid (photographed in 2008)

Furthermore, the masonry technique used in the Red Pyramid follows the same horizontal-course method employed in the upper portion of the Bent Pyramid.

In fact, it is possible that the Red Pyramid could have been completed with a steeper angle.

However, the project leaders and technical specialists likely adhered to the proven 43-degree design, prioritizing structural safety and design margin.

Thus, the management style established during the construction of the Bent Pyramid—one that incorporated expert advice—was continued.

Another point of change from the Bent Pyramid to the Red Pyramid lies in the shape of the core stones.

Figure 7-4 shows photographs of core stones from a collapsed section of the Bent Pyramid (left) and core stones of the Red Pyramid (right).

Compared with the Bent Pyramid, the stones of the Red Pyramid are noticeably flatter.

Judging from the person standing near the entrance in the photograph, many of the blocks appear to be rectangular stones approximately 1.2



Fig. 7-4. Masonry Blocks of the Bent Pyramid (left) and the Red Pyramid (right) (photographed in 2008)

meters long and 0.7 meters high.

This indicates a substantial change in stone shape.

The horizontal-course masonry of the Red Pyramid is also clearly visible.

The Red Pyramid has a height of about 104 meters, but because of its gentle slope, its base length reaches 220 meters. This is only about 10 meters shorter than Khufu's 230-meter base and longer than Khafre's 215-meter base.

In other words, in terms of base length, the Red Pyramid is the second-largest pyramid in Egypt.

The emphasis on safety in design resulted in the use of an enormous quantity of stone.

Sneferu, founder of the Fourth Dynasty, is known for building many pyramids.

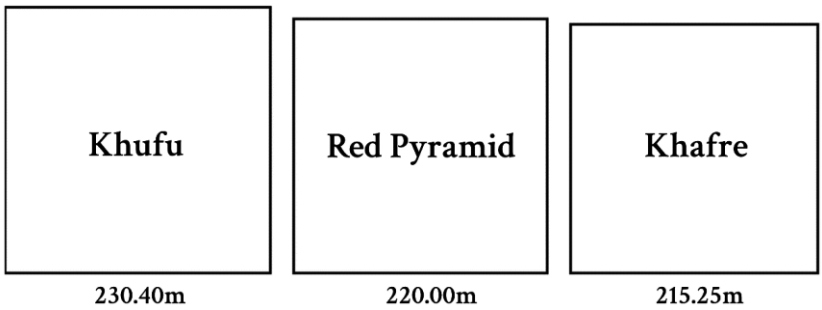

Fig. 7-5. Comparison of Pyramids with Large Base Areas

However, he did not simply construct similar structures repeatedly; rather, each project involved significant technical changes.

The willingness of Sneferu and his administration to accept the "failed" appearance of the Bent Pyramid demonstrates remarkable flexibility.

Their readiness to embrace technical trial and error—"failure as the mother of success"—evokes the adaptive organizational culture of modern startup enterprises.

Nevertheless, although the Red Pyramid was successfully completed, it is likely that the king and his advisors were not entirely satisfied.

4. How Three Large Pyramids Could Be Built During Sneferu's Reign

The reign of King Sneferu is generally considered to have lasted 24 years in both the British and American chronologies, although alternative views exist.

The most notable of these is Rainer Stadelmann's proposal of a 48-year reign, based on numbers found on core stones of the Red Pyramid and interpreted through the biennial cattle-count system.

Stadelmann's reasoning stems from the perception that constructing three large pyramids within 24 years is "mysterious" or implausible.

Figure 7-6 shows the reign lengths of the Fourth Dynasty kings.

The vertical axis represents the reign length, with wider rows indicating longer reigns.

The silhouettes of the pyramids are drawn to the same scale, using the established slope angles.

This comparison makes clear how exceptional Sneferu's 24-year period is: three large pyramids, each comparable in size to those of later kings, were built within a single reign.

The Meidum pyramid is not small; it is larger than the pyramids of Djedefre and Menkaure.

The Bent Pyramid and the Red Pyramid, though not located at Giza, are comparable in scale to the large pyramids there.

Thus, questioning whether three such structures could be built in 24

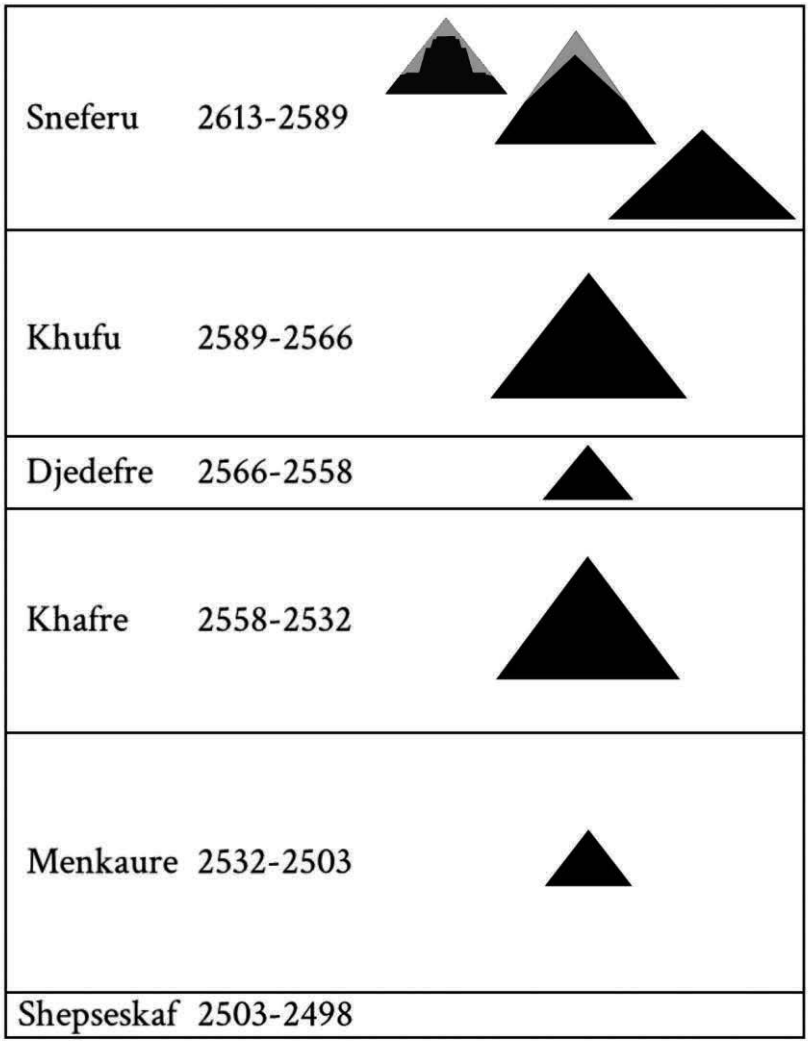

Fig. 7-6. List of Fourth Dynasty Kings and Their Reign Lengths with Associated Pyramids

years is understandable.

Stadelmann begins his argument from this point and presents a table summarizing the total stone volumes of Fourth Dynasty pyramids and associated structures.

Table 7-3. Stadelmann's Average Annual Work Output for Fourth Dynasty Kings

King	Structures	Stone Volume	Reign Length	Average Annual Work Output
Sneferu	Dahshur pyramids and associated temples	3,752,500 m^3	24	156,350 m^3/year
Khufu	Pyramid, subsidiary pyramids, causeway, temples	2,700,000 m^3	23	117,400 m^3/year
Djedefre	Unfinished trench	230,000 m^3	8	28,500 m^3/year
Khafre	Pyramid, valley temple, causeway	2,200,000 m^3	26*	84,500 m^3/year
Menkaure	Pyramid, mortuary temple, subsidiary structures	320,000 m^3	18	18,000 m^3/year

** Khafre's reign length is missing in the Turin King List; Stadelmann supplements it.*

In Table 7-3, the reign lengths follow the Turin King List.

What is striking is that Stadelmann uses Sneferu's exceptionally high average annual work output as the starting point of his argument.

However, as he himself states, "these average annual work outputs naturally contain significant distortions, as the work process was not linear…", acknowledging that pyramid construction varies greatly between the preparatory phase, the main masonry phase, and the finishing phase.

Despite this explicit caveat, he does not sufficiently incorporate it into his subsequent reasoning and again relies on average annual output to discuss reign length.

Stadelmann further asserts that an annual output of approximately 84,500 m^3 would have been feasible, whereas 156,350 m^3 would have

been “absolutely impossible.”

Yet he provides no systematic engineering or organizational justification for this conclusion. He does not demonstrate which processes—quarrying, transport, ramp logistics, staging, placement, casing-stone dressing, or material supply—constituted bottlenecks, nor how these constraints determine the upper limit of annual output.

Thus, his absolute statement cannot be regarded as grounded in engineering analysis.

Moreover, throughout his treatment of the biennial cattle-count system, Stadelmann builds hypotheses upon further hypotheses, and he does not present sufficient evidence to justify interpreting the numbers on foundation stones as regnal years.

Consequently, his proposal of a 48-year reign for Sneferu has not influenced the established chronologies used in either British or American scholarship.

It appears that his argument was ultimately regarded as no more than a speculative hypothesis.

Nevertheless, although Stadelmann’s claims involve certain leaps in logic, the question he raises—whether three large pyramids could be built within 24 years—deserves examination.

Therefore, I deliberately retain the 24-year reign as a fixed premise and consider here whether Sneferu could indeed have completed three large pyramids within that period.

In Chapter 5, I presented Fig. 5-1: Workforce Dynamics and Construction Phases, which proposes that pyramid construction consists of four phases:
the preparatory phase, the construction phase, the stagnation phase, and the finishing phase.

If Sneferu’s three pyramids were built sequentially—Meidum first, then the Bent Pyramid, then the Red Pyramid—each would need to be completed in roughly eight years.

I agree that such a sequential model makes the 24-year timeframe implausible.

However, pyramid construction can be divided broadly into two major phases: the construction phase, involving core masonry and ramp building, and the finishing phase, involving casing-stone polishing and ramp dismantling.

These phases require different types of labor.

Furthermore, the stagnation phase must be considered.

When one pyramid enters stagnation or transitions into its finishing phase, workers involved in quarrying and masonry can be reassigned to another pyramid, enabling parallel construction.

Meidum and Dahshur are separate locations, so it is not unreasonable to assume that construction of the Bent Pyramid began around the time Meidum was being converted into a true pyramid.

In this book, however, I adopt Kurt Mendelssohn's hypothesis that construction shifted to Dahshur because the Meidum pyramid began to collapse.

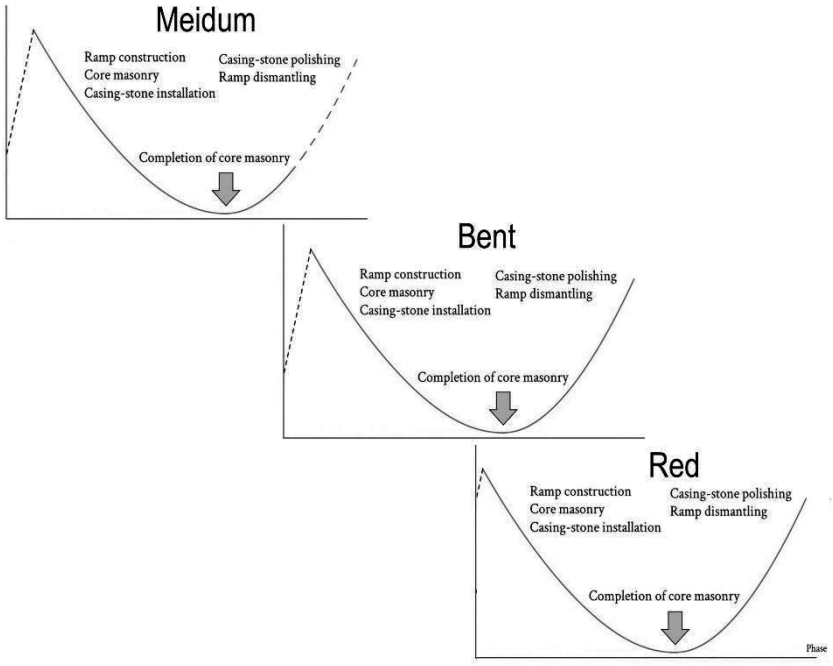

Fig. 7-7. Conceptual Diagram of Pyramids Constructed in Parallel

The reason for building the Red Pyramid after the Bent Pyramid is more straightforward:
although the Bent Pyramid was completed, partial collapse had already begun, making the construction of a new, safely designed pyramid an early necessity.

Under this model, once a pyramid enters its stagnation phase, work on the next pyramid can begin.

The relocation from Meidum to Dahshur required new infrastructure, but the transition from the Bent Pyramid to the Red Pyramid likely benefited from existing facilities, allowing rapid initiation of construction.

Even with parallel construction, building three large pyramids in 24 years is an extraordinary undertaking.

However, I believe it was not impossible.

Why was it feasible to begin new pyramids in rapid succession?

If Meidum began to collapse, and if the Bent Pyramid also showed signs of failure—resulting in its bent shape—then the motivation to build new pyramids was strong.

This is my hypothesis:
before any royal command was issued, quarry workers, laborers, and lower-ranking overseers may have preferred to continue pyramid construction rather than face unemployment or reassignment.

This is a natural human tendency, and even today, large-scale projects often lead to subsequent projects of similar type, driven partly by inertia.

I do not go as far as Mendelssohn, who suggested that pyramid construction had to continue as a national enterprise.

However, pyramid building likely functioned as a kind of flow-production system, making transitions to new projects relatively easy and consistent with the desires of the workforce.

Finally, Stadelmann's paper raises another point of interest: the upper casing stones of the Red Pyramid have not been found.

It is puzzling that the lower casing stones remain while only the upper ones were supposedly removed in later periods.

From the perspective of stone-robbers, removing stones from the lower portion would have been far easier, as seen in the pyramid of Khafre.

It is therefore possible that, to shorten the construction period, the Red Pyramid had its casing stones installed and polished only on the lower portion, and that the upper portion never received casing stones at all.

If so, the finishing phase shown for the Red Pyramid in Figure 7-7 would have been even shorter.

I will discuss this question further in Column 6 at the end of the book.

Column 4. Is "the year after the 13th cattle count of King Khufu" equivalent to his 27th regnal year?

In Japan, both the national fiscal year and the fiscal years of most companies begin on April 1, unlike in Europe and the United States. This makes Japanese readers naturally familiar with the idea that the solar calendar year and the fiscal year do not coincide.

For Western readers, this may seem unfamiliar, but many will recall that in several Western countries the school year begins in September, which likewise does not align with the calendar year.

The 13th cattle count was not conducted on New Year's Day, nor is it even clear in which month it was regularly held.

What is clear is that references to the "nth cattle count" were widely used among officials as a practical means of indicating the year.

Now, what happens if the beginning of the new year and the cattle count event were not synchronized?

If the 13th cattle count had already taken place, the new year had begun, and the 14th cattle count had not yet occurred, then describing that moment as "the year after the 13th cattle count" would be entirely natural. In school terms, it would be like becoming a second-year student in September, then celebrating the New Year while still being a second-year student until the following August.

There is nothing strange about this.

Therefore, the mere presence of the expression "the year after the cattle count" does not logically imply that the cattle count was biennial.

On the contrary, the apparent absence of expressions such as "the second year after the cattle count" suggests that the cattle count—although its timing may not have been fixed—was likely conducted annually.

At the very least, the claim that "the cattle count was normally biennial, but during Khufu's reign it was exceptionally annual" seems to me an arbitrary and strained interpretation.

Thus, “the year after the 13th cattle count of King Khufu” may correspond not to his 27th regnal year, but rather to his 14th year.

More strictly speaking, since we do not know whether the cattle count was annual, the only logically accurate description would be: “the year after the 13th cattle count, at a time when the 14th had not yet taken place.”

In other words, the number of cattle counts cannot serve as a reliable measure for calculating regnal years.

After drafting this column, I became aware of William S. Smith’s 1952 article Inscriptional Evidence for the History of the Fourth Dynasty.

Smith, writing at a time when the biennial-count theory was widely accepted in British Egyptology and when the Turin King List’s figures were treated with great authority, struggled to reconcile these conflicting data.

He even proposed that during Sneferu’s reign the cattle count may have shifted from biennial to annual partway through.

Yet Smith’s scholarly attitude was cautious. He refused to treat inscriptions containing only numbers as valid evidence unless they included full date formulae; he noted that the phrase “the year after” does not necessarily imply a biennial system; and he pointed out contradictions between the Palermo Stone and the biennial-count theory.

Thus, although he leaned toward the biennial interpretation, he did not regard it as absolute.

Gardiner, in "Regnal Years and Civil Calendar in Pharaonic Egypt," identifies the hieroglyphic notation for "occasion" (), which combines with "before" or "after" to form cattle-count date formulas. Whether this notation is present or absent is likewise significant.

It is somewhat regrettable that both Smith's careful scholarly stance and the contradictions he identified have largely been forgotten, and that the biennial-count theory is now often treated as if it were firmly established. There remains, in my view, ample room for re-examination.