

The Pyramids and Implementing Project Management Processes.

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Introduction

The superior construction, scale, and accessibility to Cairo of the Gizeh Pyramids have made them the most famous of the Seven Wonders of the World. The pyramids were simply tombs for the Pharaohs. The Great Pyramid in its original state rose 481 feet and is estimated to have contained 2,300,000 blocks of stone. Napoleon estimated that the blocks of stone from the three Gizeh pyramids would have been sufficient to build a wall ten feet high and one foot thick around the whole country of France.

This paper addresses the building of the pyramids and the concepts behind this great project. The intent of the paper is to conduct an analogy between what happened 2600 B.C. and the current principles and processes of project management as outlined in the 1996 *Guide to the Project Management Body of Knowledge (PMBOK Guide)*, by the Project Management Institute (PMI).

This analogy covers some of the key project management processes: initiation, scope planning, scope definition, activity definition, activity sequencing, activity duration estimation, organizational planning, resource planning, staff acquisition, as well as risk, quality, and communications aspects. The goal is to compare the management of this major construction project that involved about 4,000 construction workers at any given time to what we believe are today's acceptable project management techniques and principles.

Lessons learned from that major effort and how we can improve today's practice of project management are also addressed in this paper.

Project Charter

The project charting team was composed of the chief architect (project manager), who directed a team of architects. The architects gave their instructions to surveyors. The surveyors in return marked out the site and laid out a thirteen-acre site at Gizeh. The Pyramid's base was designed to form a perfect square. After this layout was done, the architects directed sculpture workers who were to chip rough gutters or slots in quarry walls. Workers then fitted the wooden wedges into the slots, soaked them with water, and the wood expanded

and split off chunks of rock. The massive stone chunks were then hammered into rough blocks. A true delegation of authority at all levels.

The blocks were painted with a variety of quarry marks. Some of the marks indicated the block's destination; others cautioned, "this side up." Others gave the name of the quarry gang, such as "the vigorous gang." The responsibilities were divided among groups of workers and every group was held accountable for the destination and the section they were responsible for in this project. Special dolerite hammers were used to chip the stone. Some of the stone blocks were granite, but the most were limestone.

The team was getting the direct sponsorship of the king due to the strategic importance of this project to the kingdom and to the king's immortality.

Scope Planning

The statement of work's key deliverable was a structural monument meant to preserve the king's body for resurrection based on the ancient Egyptians' strong belief that, in the afterlife, he would use same body, which therefore needed to be protected.

Scope Definition

The structure was selected to be a pyramidal architectural structure based on a theory projected by the first pyramid engineer, Imhotep, who designed the step pyramids in the Third Dynasty. The structure was meant to be solid enough to defy wear and tear over centuries until the time that the bodies were ready for the other life. The original plan was established to place the monumental structure in a certain spot, which was planned precisely, though not all the details are available to us at the present time. Recently it was discovered that the arrangement of the three pyramidal structures matches a triad of stars in the constellation Orion. The structures were meant to be close to the river Nile, the main route for transportation in Egypt at that time. The project plan was to use the Nile to transport the pink granite stones from quarries in Upper Egypt down the Nile to Gizeh.

Activity Duration Estimation

Despite the magnitude of the project, the plan was to complete the structure within the Pharaoh's reign. This schedule was actually met and the Great Pyramid was built within the Pharaoh's twenty-three year reign in about 2600 B.C. by men working with the simplest implements, without draft animals, without even the wheel, which was not known at that time.

Activity Sequencing / Staffing Issues

This project used 100,000 workers divided into groups with about 4,000 construction workers working at any given time. Workers were divided into shifts to maintain work continuously around the clock. They were free citizens drafted for public work. Laborers worked in gangs of eighteen to twenty men, hauling stone blocks up ramps and setting them in place.

Workers at Aswan chipped off the blocks of stone and eased the stones onto log rollers. Whichever surface of the granite block was to be moved face down was finished beforehand so it would slide smoothly onto the ramp. At the ramp's end, workmen loaded granite blocks onto a wooden sledge. By using rollers, ramps, and sledges, work gangs were able to haul blocks weighing up to fifteen tons from the quarry to barges waiting along the Nile hundreds of yards away. At the same time at the pyramid site ramps were built in tiers along the four sides of the pyramid, three to go up and one to go down, each ramp began at one corner and all ended at the topmost level of the construction.

The laborers hauled the heavy stone blocks up the ramps sitting them in place. Finally from the 481-foot apex, the masons cut down the blocks to form the smooth sloping sides of the pyramid.

In essence, some of the activities overlapped and others were in sequence, indicating the old Egyptians' ability to understand different logical sequencing alternatives.

Team Issues

Despite the great labor, gangs were pleased to work for the Pharaoh, who was God's figure on earth. As a later foreman said, they toiled "without a single man getting exhausted, without a man thirsting," and at last "came home in good spirits, sated with bread, drunk with beer, as if it were a beautiful festival of a God."

The Egyptians demonstrated outstanding engineering skill in designing this outward size pyramid that was called one of

the Seven Wonders of the ancient world. King Khufu had planned a somewhat smaller pyramid with his burial chamber sunk deep into bedrock below the base. But as his aspirations grew, he twice enlarged the tomb's plan and each time ordered the burial chamber to be raised higher up, a scope change that was well handled by the project team, which was dedicated to pleasing the customer.

The workers who were drafted for public work were doing so at the time when the flood was covering their own land so their time was used intelligently. The workers were self-motivated with a strong belief that they were worshipping through this work devoted to the Pharaoh who was the godly figure on earth. The gangs were self-selected to work in harmony and they were actually competing with other gangs for a better job to satisfy the God whose spirit they felt was dwelling upon them.

A major lesson for us here is the issue of being "self-motivated." There's nothing stronger than a team's belief in the mission of the project, the value of individual contributions to the team, and how this ties to the bigger picture of the organization's effort.

Cost Management

Despite the magnitude of the project, expenses were amazingly very low. The entire project was established from natural resources in the form of granite and limestone blocks carved from the mountains of stone in Upper Egypt. The labor was derived from Egypt's own people, who were paid not with money, but with pure satisfaction from doing a job for worship. They received only food and drink during their working hours. The transportation was cost-free using the stream of the river Nile, carrying the wooden barges from its upper level to its lower level in the Delta via water energy. The architects competed at no charge, showing off their expertise to gain the satisfaction of the worshipped Pharaoh. The structure itself was one of the most cost-effective projects known to mankind and one which has defied time and nature. With the expenses as little as described, the Pyramids are still a source of income to Egypt through tourism over centuries past and still to come.

Since the expenses were planned to be as shown above, there was no true need for setting a budget and or exercising cost control measures as we know them today in the world of Earned Value Analysis. This was such an enormous strategic project that meant a great deal to the monarch of Egypt, who is also the godly figure, that the project was an open budget to every expense that it would take to ensure the glorification of the Pharaoh it represented.

Risk Management

The major risk in the project was the risk of the project failing to protect the body of the King and to ensure the safety of his tomb. Every precaution was taken to misguide and trap all intruders. False burial chambers were set to misguide grave robbers. The final chamber was reached through a grand gallery that was ventilated by two narrow shafts; the ascending corridor was sealed from within by stone plugs. The king's chamber was roofed with enormous granite slabs that formed five stress-relieving compartments. Now, though many slabs have cracked, the roofing remains firm. This gives us an idea of how meticulously the safety of the king's tomb was thought out. Once the ascending corridor was sealed, the workmen blocked other passages including the tomb's entrance with stone slabs. These extraordinary measures fooled even the most ingenious tomb robbers for at least 400 years.

In summary, the major risks were identified, assessed, and a risk handling strategy was carefully followed.

Quality Management

The quality of the project structure was very well thought out. They chose granite as the building material, the most challenging and strongest stone known to man. Though the Egyptians had no good timber, they imported most of what they used from Lebanon and Syria. Their achievement in woodworking was noteworthy and it has survived because of the country's dry climate. Nationally made goods were given by the people to their Pharaoh to show their gratitude. Egyptian cabinetmakers mastered the making of chariots, coffins, cosmetics boxes, and ornaments found in the tombs attesting to the remarkable skill of the Egyptian craftsman at joinery and veneering.

The architects directed the workers to cut step-like terraces into the irregular sides of the hill where the pyramid was to be erected. These terraces which would serve as the foundation on which all the stone blocks were laid, had to be absolutely levelled if the entire structure was not to be askew.

To assure this level foundation, the pyramid builders erected an extensive system of water-filled trenches about its base. Then, using the water level as a standard they were able to lay out the 13-acre site so evenly that experts using modern instruments have found that the southeast corner of the pyramid stands only 1/2 inch higher than the northwest corner.

To ensure the leveling of the stone blocks, a string was stretched between two sticks of equal length held touching the water connected in water trenches. The ground was then leveled until measuring rods showed the floor was parallel to the string.

The Pyramids of Gizeh were proven recently to be in the exact center of the world's habitable landmasses. This is believed to be attributable to the skills of old Egyptians in astronomy and mathematics.

Procurement Management

The magnitude of the project dictated the inclusion of different craftsmen with unique skills. This included Egyptian sculptors with skills in dealing with granite, basalt, and leather, Egyptian painters skilled in painting on plaster, and carvers. The paint they used was a mixture of pigment and water with wax or glue as a binder. The pigments were minerals, which is why many of the colors remain remarkably fresh. Carbon was used for black; ocher (iron ore) for brown, red, and yellow; powdered malachite (copper ore) for green; and chalk or gypsum for white.

The tomb of the king contained hundreds of vases and bowls, made from limestone, alabaster, flint, and quartz. The skill of the Egyptians acquired with small stone articles was the basis for their later mastery of gigantic stone blocks.

Communications Management

There was total harmony between teams of workers involved in the Aswan quarries cutting stones and loading barges and their counterparts on the bank of the Nile. At Gizeh, barges were unloaded and messengers carried messages on the homecoming boats to request more blocks as the establishment in Gizeh was shaping up. There was never a time when the work at Gizeh had to stop because of shortage of stone blocks. As soon as the outer design was being set up, other groups of workers were carrying out their task within the inner design of the pyramid. Every group carried on from where the previous one stopped. Teams functioned without getting in the way of one another. A beautifully orchestrated project plan.

The proof of this harmony in planning the building of the Pyramid was quite obvious in completing such wonder within twenty-three years with this big numbers of workers, at least 4,000 of them working at any given time without any chaos.

Communications were planned for, no barriers to communication existed, and information distribution and close out were easy and clear. Workers had no computers, e-mail, pagers, or answering machines, and yet communication was flawless.

Conclusions

Nothing about the Pyramids was accidental. Their original heights, their angles of slope, their perimeters, and many other aspects were purposefully laid out according to a specific plan. As an example of the the high precision followed in this major project: if we require a wall that is straight within 1 arc minute per 100 meters and directed exactly due north, then we are going to need a laser theodolite, an accurate survey map, and a qualified professional team. Yet this is the precision that was achieved by the builders of the Great Pyramid more than 4,500 years ago.

Another example is the Pyramid's base. The variation between the longest and shortest sides is less than eight inches, about one-tenth of 1 percent, which is an amazing fact considering that this is measured over a distance of more than 9,000 inches. In addition the corners were set at almost perfect right angles, the kind of accuracy involved in building a Rolls Royce.

The builders of the Pyramids must have had a powerful motive to create what is truly a miracle of surveyor's art. It is this conclusion that drives us to go back to basics in project management and to have the open eyes and mind to learn from other global projects and project managers.

Lessons Learned

Meticulous choice of the materials used to build the structure ensured the strength of a structure that was able to challenge time and weather changes over centuries. Extreme precision in leveling the foundation protected the establishment of the structure.

The dedication of the crews involved in their tasks allowed them to work in harmony, in one unity, for one goal, to establish a monument that could survive eternity. The most valuable lesson to learn is "whenever there is a will there is a way" in managing any project even one of this magnitude.

The realization that planning needs to be driven by what the key deliverables are, and that the belief of the team in the value of the pursuit is very important. Even the Pharaohs knew the value of emphasizing the conceptual phase, the significance of project managers negotiating for deliverables, and how they must lead and motivate team members. Quality of the work came about smoothly since it was planned for and prevention money was spent up-front so that the errors were kept to a minimum.

Project management processes, as laid out in the *PMBOK Guide*, were used thousands of years ago in this major project. The newly agreed upon and developed terminology in the *PM-BOK Guide* should help our organizations communicate and

handle present and future project challenges hopefully at least as well as the Pharaohs did.

References

- Casson, Lionel. 1974. *Ancient Egypt*. New York:Time-Life Books.
- Hancock, Graham and Robert Bauval. 1996. *The Message of the Sphinx*. Three Rivers Press.
- Putnam, James. 1990. *Egyptology*. Shooting Star Press.