The Evolution of Project Management: The Future Is Now?

Mary B. Griffin
University of Central Arkansas

Joseph Y. Thomas
University of Central Arkansas

Mark E. McMurtrey
University of Central Arkansas

When people think of project management, they usually think of someone looking at a project plan and then telling other people when their part needs to be finished. But it wasn't always this way, early project managers didn't have the technology we do today to complete their projects on time and on budget. This paper looks at the innovations that have been created to help make the modern project manager's job more manageable, some of the advances in technology, as well as changes in society that will impact how project managers do their jobs in the future. Some of the ideas have been around for more than a century, some are relatively new, and some are just beginning to be relevant but all of them contribute to the success not only of the individual project but the company.

Keywords: project management, PERT, critical path, agile, work breakdown structure

INTRODUCTION

Project Management has been around since about 2570 BC when the Egyptians built the great Pyramids of Giza. However, until the invention of the Gantt chart in 1917, modern project management didn't really start. Newer processes such as Critical Path, Program Evaluation and Review Technique (PERT), Work Breakdown Structure (WBS) and Agile followed, taking project management into new avenues the Egyptians, and probably the engineers who built Hoover Dam, would find daunting. Many companies didn't really start employing dedicated project managers until the late 1950's and early 1960's. Becoming a certified Project Management Professional only began late in 1984 when the Project Manager Institute (PMI) held the first certification test. But how did this evolution of Project Management take place and why is this important in business today? This paper will look at the evolution of Project Management and the reasons it is one of the fasted growing occupations in the world. Through 2027, project management jobs are expected to grow by 33% or nearly 22 million new jobs (Project Management Institute, 2021).

Project Management in Giza

The pyramids were filled with everything each ruler believed they would need in the next world. Archaeologists have determined that these pyramid sites reveal a highly organized community, rich with

resources, that must have been backed by a strong central authority (Handwerk, 2017). Some estimates suggest that as many as 50,000 people were needed to build a pyramid. Not only were there construction workers but carpenters to make tools and sledges, metal workers to make and sharpen cutting tools, potters to make pots for food preparation and hauling water for mortar and other purposes, bakes, brewers and others (Building the Egyptian Pyramids, 2020).

The project managers, most likely the ruling class and or the pharaohs, needed at least 8 of the 10 skills the PMI says a project manager needs to be successful: Integration, Scope, Schedule, Quality, Resource, Communication, Risk, and Procurement management. Neither cost management nor stakeholder management seems to have been an issue for building these massive structures.

Resource management appears to be the biggest challenge for the project managers responsible for building the pyramids. How do you organize 50,000 men to build what you need, when you need it? According to hieroglyphics found in the tombs, men were organized into different groups, the smallest being around 200 men. Bread, beer and onions were used as payment for the men's services and the project managers had to ensure these resources were managed carefully or labor unrest would follow. Strikes for to non-payment of onions have been documented (Ismail, 2013, March 13).

Additionally, to build the Great Pyramid researchers believe that 5.5 million tons of limestone, transported from Aswan, almost 500 miles away and 500,000 tons of mortar were used (Piazzi Smyth, 1978). Archaeologist Mark Lehner says that when the Nile River was in flood, Egyptians could steer boats laden with stone to a major port city at the pyramid complex (Finucane, 2017). The limestone was then loaded on to a wooden sled to haul the stone and recent studies suggest that the Egyptians wet the sand before moving the sled containing the limestone over it (McCoy, 2014).

Projects such as the Great Wall of China built, in 208 BC and the Transcontinental Railroad, built between 1863 and 1869, were constructed using project management processes such as schedule and quality management. However, since everything was done by hand or with relatively primitive tools, those projects took considerably longer to finish than they would have following Henry Gantt's revolutionary invention.

The Gantt Chart

Henry Laurence Gantt was a mechanical engineer and management consultant. Born in Maryland in 1861 to a family of prosperous farmers, his family underwent some financial struggles due to the conditions of the family fields after the Civil War (Charted Management Institute, 2015). This may have sparked Gantt's interest in management as he was an early promoter of the scientific school of management. He worked with chief engineer, Fredrick W Taylor, who published his book The Principles of Scientific Management in 1911, at the Midvale Steel Company in Philadelphia (2015). With a talent for problem solving, Gantt attempted to address the technical problems of scientific management. He believed that only the application of scientific analysis to every aspect of work could produce industrial efficiency, and that improvements in management came from eliminating chance and accidents (2015).

Although most famous for his chart, Gantt also made three other notable contributions to the art of management: The task and bonus system, the perspective of the worker, and the social responsibility of business (2015). The task and bonus system rewarded employees with a bonus in addition to their regular pay if they accomplished the task for the day, and they still received the day rate even if the task was not completed. This enabled workers to earn a living while learning to increase their efficiency, and production often more than doubled (2015). Gantt also introduced the perspective of the worker which was one of the earliest recorded attempts to reward the foreman for teaching workers to improve the way they worked. As Gantt got older, he believed that management had obligations to the community at large, and that profitable organizations had a duty towards the welfare of society (2015).

The Gantt chart is and was his greatest contribution to modern Project Management. Prior to this time, charts were used to detail what 'had' happened, rather than planning for the future. Trying to figure out how to track the various tasks and activities of the various government departments on the war effort, he had an epiphany; he should be scheduling based on time rather than quantity. This epiphany leads to the development of his Gantt Chart. The Gantt progress chart enables the manager to keep before him all the promises he has made, to concentrate his attention on overcoming obstacles and avoiding delays, and, when

it is impossible to live up to a promise, it enables him to give the customer advance notice of the fact (Geraldi, & Lechter, 2012). Furthermore, the Gantt chart allows anyone to look at a project and understand if it is on track quickly. In essence, Henry Gantt develops the first prototype for what we now call visualization. His chart allows you to see, most times with a glance, the status of your project. That the Gantt chart is widely used in Project Management today, more than 100 years later, is a testimony to how the Gantt chart really changed Project Management.

Critical Path

Between 1940 and 1943, when the staff and consultants of the E. I. Du Pont Nemours Co developed Critical Path Method (CPM), Project Management acquired its next big milestone (Olson, 1969). The basic principles of critical path have been in use for hundreds of years; however, this was the first known attempt to set down a systematic and logical approach for the solution of scheduling problems (Olson, 1969). Very simplistic in nature, CPM does not require any more information than is required for the preparation of a bar chart.

DuPont was one of the major contractors on The Manhattan project. This massive undertaking, requiring the synchronized work of more than 130,000 people and costing an estimated $2 billion (more than $23 billion in 2019 dollars), was even more complex when you add the additional criteria of having to be coordinated so that no one except the most senior executives and commanders knew the ultimate purpose of the project due to security risks (Johnston & Williamson, 2022). The engineers developed CPM into a system that could be used across the project while keeping the compartmentalization that was critical to the success of the Manhattan Project. The complexity of the project was simplified by the compartmentalization according to tasks, objectives and teams.

Consisting of four basic steps: find activities; build schedule network diagram; find all possible paths and calculate duration for each path; CPM requires only basic addition and subtraction to allow for success. Adding some additional steps allows for more complex planning of larger projects but the math is still basic addition and subtraction (Armstrong-Wright, 1969).

This simple idea creates a schedule of project activities which help managers achieve objectives for the project such as estimate the completion date of a project, identify the start and finish time for each activity and calculate the amount of slack time for each activity. CPM is based on the idea that some (usually most) tasks can slip or be delayed without impacting the project's delivery; some, however cannot. The activities that cannot be delayed are said to be critical since the project timely delivery depends on their scheduled completion, and the combination of all these critical activities is known as the critical path (An Introduction to Critical Path Project Management, n.d.).

Critical Path Method allows project managers to understand the timeline of their project. Being able to figure out contingency plans relatively quickly and simply using basic math means that project managers can adapt to most situations without losing massive amounts of time trying to figure out how to make up time or what to do while some tasks are stalled. Critical path methods give to project management the scale for measurement. Their usefulness is first, in planning a project, which is the strategy to marshal and schedule resources; secondly, in project control which is the tactic to redeploy resources, show just how best to 'trade off' slippages in some activates against float, good fortune or crash actions on others (Battersby, 1967).

More than eighty years after its structured design, CPM is still in use today. The Project Management Institute (PMI) requires demonstrated knowledge of CPM to become a Certified Project Manager Professional (PMP), the gold standard for project managers in the industry. Although, CPM is used for many projects, both simple and complex, it needed some help when it came to completing projects with unknown variables.

Program Evaluation and Review Technique (PERT)

Planning is a hallmark of project management. However, CPM requires knowledge of not only the activities needed to complete the plan but the time it takes to complete those activities. Those details are not always known, especially when developing something new. The U.S. Navy struggled with this

limitation of CPM, which led to the creation of a system designed to add more defined time to projects in which the details and durations of the activities are unknown. The program evaluation and review technique (PERT) was developed in 1958 to aid the U.S. Navy's Polaris nuclear submarine project (Malcolm, et.al., 1959).

Traditionally, project managers were concerned with when will a task start and when will it end to develop a timeline for project completion. PERT is an event-oriented technique rather than start and finish completion oriented, and primarily used when time is the major factor rather than cost. In the case of the Polaris nuclear submarine project, time was of the essence since the U.S. knew the Soviet Union was able to launch intercontinental ballistic missiles and no land or air-based nuclear arsenal were safe from attack anywhere in the world (Taweel, 2008).

Building something without knowing how long it would take for completion presented numerous problems for the Polaris design team. PERT used a probabilistic approach, where three estimates for the duration of an activity were made and mathematically assessed. These three estimates were the optimistic (A), the pessimistic (B) and the most likely (M) times for the duration of each task in the program (Littlefield & Randolph, 1991). U.S. Navy engineers were the most knowledgeable of the activities needed to complete the project. The individuals in charge of each activity knows the schedules and estimates for his work (Littlefield & Randolph, 1991).

This process of producing three estimates allows for everyone to know what is expected to complete the plan. They generate measurable outputs with associated time limits that both (superiors and subordinates) view as realistic and obtainable ((Littlefield & Randolph, 1991). The Polaris project engaged more than 250 main contractors and 9,000 subcontractors in order to execute more than 70,000 work packages. PERT allowed the U.S. Navy to deliver the Polaris submarines two years ahead of schedule (Engwall, 2012).

PERT, in conjunction with CPM, continues to be used in project management today especially in highly complex engineering projects. Based on the analysis, it is possible to assess the completion times for the three estimates for construction works. The approximations of triangular and normal distributions allow us both to assume the duration and assess the probability of completion of certain construction work within the assumed period of time (Plebankiewicz, Juszczyk, & Malara, 2015). PERT is not part of the certification process for PMP probably because project management is not confined to large engineering jobs and many project managers are not engineers.

Work Breakdown Structure

Along with planning, controlling is a large part of a project managers day to day activity. Managing several teams and projects at once, all with many moving parts can be overwhelming to control. The U.S. Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA) understood this situation and in June 1962, NASA and DoD published a document regarding PERT/COST which was the first approach to the Work Breakdown Structure (WBS).

Work Breakdown Structure (WBS) is a list of all the tasks or activities required to complete the project under study. It is a hierarchical process moving from the very general and ending with the very specific (Linton, 2006). Project managers are often assigned projects in fields in which they have limited or no expertise. The WBS aids in scheduling, estimating costs and determining risks. The Project Management Body of Knowledge (PMBOK) guide, the project manager's bible, if you will, provides an overview of WBS and how to use it. Additionally, understanding WBS is a component of the certification process for becoming PMP certified.

A WBS is like the foundation of a house, a structure of high quality can be built on a strong and complete foundation. Based on simple decomposition of a project, where the first level is the entire project, which is then broken down into component parts until the tasks or components are specific enough that there is no advantage to further breaking down the activities (Linton, 2006).This process is a team effort involving all the project resources to assure that the tasks are broken down completely. Each task must be actionable by a limited number of people and equipment; be deliverable within the scope of the project; consume resources; require the passage of time and be assigned to an individual who is responsible for the

monitoring and completion of the task (Linton, 2006). This allows the overall project manager to have control of the project without having to micromanage each aspect of it.

Once the WBS is complete, project managers can then use CPM to determine critical path and overall project completion time. Microsoft Project, a computer application widely used for project manager activities, includes a component for WBS based on activities in the project. Using this software, or other project management software, the project manager can then determine how much the entire project will cost and how long the project will take to complete (the length of the critical path), when different activities should be started and completed, the effect of spending money to reduce the time of all activity (crashing) on the project completion date, the effect of delays in any part of the project and the resources required at different time to complete the project (Linton, 2006). This is critical because throwing more people or money to the project does not automatically mean the project will then be on time. More ability to plan and control the project helps to ensure that the project manager and the company they work for, are more successful.

Agile

CPM, PERT and WBS all contribute to make a project manager highly successful. However, leaders and project managers are increasingly in environments disrupted by exponential advances in technology and demands from customers for more immediate delivery of value. This demand from customers for more information quicker led, in the spring of 2000, to a group of 17 software engineers meeting in Oregon to discuss how they could speed up development times in order to bring new software to market faster. Waterfall, another project management approach, was typically used to identify problems and plan a solution (Lynn, n.d.). The problem with the Waterfall approach is that it could take years to complete a project and during this time the problems and the technology could change but the project requirements would not. During the meeting in Oregon, the software engineers identified two key opportunities that achieving this goal would make possible: shortening the delay of benefits to users in order to resolve the product-market fit and development graveyard problems and getting feedback from users quickly to confirm the usefulness of new software and continue to improve on it accordingly (Lynn, n.d.).

This led to the beginning of the development of the Agile approach. The Manifesto for Agile Software Development is based on four values: Individuals and interactions over processes and tools; working software over comprehensive documentation; customer collaboration over contract negotiation and responding to change over following a plan (Project Management Institute, 2021). Basically, Agile allows for project teams to be more reactive to changing conditions in the project. It also allows for better customer satisfaction. The first principle of agile places customer satisfaction as the highest priority and is the key in delivering products and services that delight customers (Project Management Institute, 2021).

Today, Agile is part of the PMP certification process and more companies are incorporating this method to deliver superior customer satisfaction while also managing cost and delivery to market. Using small increments allows teams to verify their work, which, in turn, allows for teams to change what they do next. When teams deliver small increments, they are better able to understand the true customer requirements faster and more accurately than with a static written specification.

Project Management Institute

What began as a dinner in early 1969, when three men met at the Three Thress Restaurant in Philadelphia, PA has become the leading not-for profit professional membership association for the project management profession, the Project Management Institute (PMI). PMI encompasses eight certifications that recognize knowledge and competency, global standards, chapters and community, training and education, thought leadership and academic research.

The first PMP certification examination was conducted in October 1984 and since that time more than a million project management professionals hold the coveted certification. PMP certification has become the industry standard for certification in project management. In 2007, it earned the ANSI/ISO/IEC 17024 accreditation from the International Organization for Standardization. Recruiting volunteers to create industry standards, the first "A Guide to the Project Management Body of Knowledge" was published in

1996 by PMI (Healy, 2010) and it attempted to document and standardize accepted project management information and practices. There have been six updates to the PMBOK, since then. The latest version, the 7th edition, was published in August 2021. Each edition contains updates to the previous one based on new methodologies. The 6th edition included content on Agile project management as Agile has become one of the fastest growing project management methodologies.

PMI is a forum for project management professionals to learn new methods to solve problems, connect with other project management professionals and to keep PMP certification up to date. Each project manager who becomes certified must keep their credentials up to date by earning 60 professional development units (PDU) every three years. These PDU's are broken into four different areas: technical, leadership, strategic and business, and giving back. This emphasis in keeping project managers up to date with current methodologies and events helps maintain the prestige of earning PMP certification.

FUTURE OF PROJECT MANAGEMENT

As demonstrated earlier in this paper, project management evolves as new innovations in technology and new demands on customer satisfaction develop. Throughout history, when these changes occur, project management adapts, and new processes are created to manage those changes. Two thousand twenty-one was a challenging year for many businesses as they navigated the multiple avenues of change that was taking place due to the COVID pandemic. In addition, breakthroughs in technology have and will change the landscape that project managers work.

Project managers have and will continue to have, a greater reliance on digital and remote teams. Clear and open communication has always been a key strategy for effective project management, but it will become even more relevant as this trend continues to evolve (Stobierski, 2020). This means that using WebEx, Teams or Skype to have meetings is on the rise. Project managers must prepare for these meetings in advance because there is no longer the ability to have an impromptu meeting in the hall with team members. The inability to have impromptu team meetings means project managers must ensure that all their meeting objectives are met during the time allocated for the meeting. Additionally, many team members are working on other projects, so project managers must be even more careful with team members time so effective, productive meetings are necessary to ensure that projects are being moved forward.

Given that most business is now conducted via the methods described above, it is more important than ever for project managers to develop more soft skills. Effective project managers must be able to anticipate the needs of their team, understand their hopes and motivations, and identify and remove roadblocks before they impact the progress of a project (Stobierski, 2020). Doing meetings over the computer is not always the same as being there. Before the pandemic, talking with a teammate one-on-one, in person was an effective way to help to understand the challenges that team member was facing especially when a project was not progressing as the project manager would like. Body language, eye contact and tone of voice all helped project managers to identify issues with the teammate and begin to help solving the problem. Issues with internet speed and reliability hampers this one-on-one interaction, even when the meeting is live and face to face with a camera. Therefore, project managers must dig into their arsenal of problem solving, communication and teamwork skills to combat the challenges of only working with team members via videoconferencing.

Artificial intelligence and data analytics also play a part in the ever-changing role of a project manager. One impact of artificial intelligence, for example, will likely be the automation of many administration focused tasks that currently fall to project managers, including resource allocation, project balancing, and schedule and budget update, among others (Stobierski, 2020). Project managers spend a great deal of their time ensuring the administrative tasks of a project are accurate and complete. Having some of the more administrative duties taking less time to manage, allows the project manager to focus their skills other areas of managing a project allowing them to effect greater change and increase the likelihood of achieving the strategic goals of each project (Stobierski, 2020). Project managers will become less of a keeper of the information and more of a strategic partner with the other managers in the business.

The impact of artificial intelligence on project management is not fully realized. Both risk management and project estimates could benefit greatly from artificial intelligence. What if a smart machine could synthesize two years' worth of risk and issues logs to assign a risk index rating based upon sophisticated algorithms, thereby leveraging historical data to predict the future success or failure of a project (Ludden, 2019)? Since historically the risk analysis is developed by teams who had experience in similar projects, the teams could only list the risks that had impacted previous projects. Many of those risks became issues which would impact the progress of the project. Project managers then communicate those issues to the risk management team for analysis and evaluation of degree of risk. Project teams evaluate the risks and place them in one of three categories: known risk, unknown risk and unknowable risk (Becker, 2004). Using artificial intelligence will help businesses and project managers develop more comprehensive risk analysis matrixes in less time with more accurate results.

Project estimates will also benefit from using artificial intelligence. Traditionally, project managers use a combination of eight methods to estimate projects: expert judgement, analogous estimating, parametric estimating, three-point estimating, bottom-up estimating, data analysis, decision making and meetings (Project Management Institute, 2017). What if a robot could take three years' worth of historical information from the project or organization, leveraging productivity rates, attrition rates, holiday time, etc. to come up with an estimate of the project that could be utilized to forecast investments needs (Ludden, 2019)? Just eliminating several meetings a month would save the company time and money in project estimation alone. The additional savings of a more complete, accurate project estimate would also save businesses time and money.

Project management is changing, and project managers need to change along with it. Learning new skills, embracing the change and developing greater soft skills are key to being a successful project manager today and in the future. Since innovations such a videoconferencing and artificial intelligence are becoming more prevalent in our day-to-day life, project managers will need to not only understand those technologies and how to use them to enhance the skills they already have but to embrace the change and champion them throughout their organizations. As in the past, project managers ability to adapt to changes ensures that businesses continue to need them to get their projects completed on time and within budget. Managing people from home and incorporating new technologies secures the project managers rightful place as a highly valued members of successful companies.

CONCLUSION

From the ancient Egyptians to our modern, technologically advanced work, project management has been around for thousands of years in one form or another. Although there have been many developments in the world of project management, the basic objective to get the project completed within time, budget and resource constraints has not changed. What has changed is the use of technology and an increasing emphasis on doing more with less which has led to innovations in how projects are managed.

The ancient Egyptians had no issues getting people to work on the pyramids, there were plenty of people who wanted or needed the work. Time wasn't a factor either, since the pharos expected the building process to last throughout their lifetime. Building the Great Railroad wasn't limited to people resource or time issues either. Yes, it needed to be completed but it didn't really have a completion date and it employed several thousand men who all needed the work. However, in today's business environment, competition is fierce, especially in the Information Technology realm. Most service ideas cannot be patented so getting ideas to marketplace is a race. Any advantage a company uses to get their idea up and running before their competition, also gives the company an edge in creating market share.

The methodologies described in this paper, Gantt Charts, CPM, PERT, WBS and Agile, all contribute to making project managers, and the companies they support, more successful. Moreover, Project Management Professional certification assures employers that the project managers they employ are trained to the highest standards of the Project Management Institute. New technologies such as artificial intelligence and new challenges to the traditional way companies do business only highlight the need for someone to not only understand the challenges but embrace the changes to help companies stay prosperous

during the transformations of the future. Those who successfully navigate the changing dynamics of project management will always be needed. The PMI is a living, breathing resource which ensures that as new methodologies for project management are designed, and new technologies are developed, PMP certification will incorporate them into the program. Companies will continue to employ project managers who are PMP certified because it assures the company that their project managers are up to date on all the newest innovations to project management.

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