The Application of Project Management Principles During the Construction Phase of a Parking Lot Replacement Project

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Abstract

The objective of this paper is to outline a project path for the construction of a new parking lot in an Air Route Traffic Control Center (ARTCC). A conceptual framework is presented to guide the discussion based on how different Project Management (PM) tools were used throughout the project. A detailed explanation highlighting the challenges that were faced during the project execution phase and some of the lessons learned from the project are presented in this report. This article shows how PM principles were used to find the solutions for different problems during different stages of the project. It shows how a parking lot construction project can be managed by using different PM tools such as Scheduling, and Work Breakdown Structure (WBS). It highlights on some of the most used terms in the construction industry that includes scope of work, change orders, Request for Information (RFI), etc. This article reflects that with the use of Project Management techniques it can assist with an efficient yet goal-oriented project.

Keywords
Air Route Traffic Control Centers (ARTCC), Work Breakdown Structure (WBS), Request for Information (RFI), Cement Treated Base (CTB)

1.Introduction
According to the US Bureau of Labor Statics, construction sector has a huge contribution in the economy. In 2020, 4.3% of the GDP were attributable to this sector according to the Bureau. Construction projects like any other project have a set of objectives and constraints associated to these projects. These projects can range from a small home renovation to the construction of a very large highway or the airport. This report will delve into a construction project where the scope was to replace the entire parking lot in an ARTCC. The report will not address the design and procurement process of the project which was done prior to the contract being awarded and the construction was scheduled. Therefore, in order to achieve better management of complex systems problems, we need to adopt a more 'systemic' approach (Nagahi et al. 2019)A critical aspect pertaining to this project is management of the traffic flow in a 24-hour facility while the construction continued. Project management today is a flexible method for managing large or small endeavors (Meredith et al. 2017).

The experience of project management must be analyzed in detail to understand the methods that corresponds to the specifics of these projects and can be used to effectively manage such projects under modern risks. The most common problems in managing a project include staying within budget, within time constraints, and within scope of the project (Meredith, Shafer & Mantel 2017). Weather is also an important factor that needs to be considered with this project. This project has specific limitations which state that this work must be performed under specific weather conditions. Communication with the stakeholders is another important aspect of this project since it is required to provide a two-day notice before closing any area within the facility for construction purposes. These avenues of communication are imperative as a means of avoiding unforeseen circumstances that can arise during the construction process.

1.1 Objective

As with most construction projects, getting the mission accomplished seems to be the hardest obstacle. For this project it was important to make sure that the daily construction didn't interfere with the day-to-day operations. This facility is occupied by employees who are tasked with perform their duties without any disturbances. Any noise or vibrations caused by the construction crews could affect their daily operation. If digging needed to be accomplished as a part of the project, the area had to be properly examined to make sure there were no buried cables in the area wanting to excavate. Unavoidable disturbances needed to be coordinated carefully with the stakeholders and scheduled at a time when there is least affect to the operation. It is crucial to use the Integrated Risk Management Checklist (IRMC) generated for the project throughout the project completion to make sure all the risks are addressed properly. This is one of the twenty very similar parking lot replacement projects that are scheduled to take place in the future

The first step in this process is the notice to proceed (NTP) awarded to the contractor to begin the construction on site. The planning for the construction process begins during the pre-construction meeting that is held between the project owner and the contractor performing the work. During this meeting, contractors are briefed about the rules and regulations of the facility and the deliverables expected from them. Contractors can ask any questions related to the project in this meeting. Security badging of the key contractor personnel is also done during this time. It is required by the facility that a badged person is always present at the site when there is work being performed and any visitor needs to be escorted by someone that is badged. This phase will include the activity planning, scheduling, risk mitigation, and resource allocation. As a means of applying project management to the project plan, it was necessary to review these important aspects of PM and see how they will fit into the integrated project plan. Since there is a limited amount of money and resource allocated to the project, it is extremely important to map out a plan that will help in the successful completion of the project using the available resources. First step in the plan as shown in Figure 1 is to create the WBS of the project which will be helpful in tracking and monitoring the progress of the work. Using work breakdown structure can be very helpful to keep track of the completed tasks and mitigate any potential scope creep during the process. This helps to highlight the most critical tasks, so they can be kept at high level consideration. This WBS will act as the steering wheel for the entire project. Work Breakdown Structure for the parking lot replacement project is shown below:

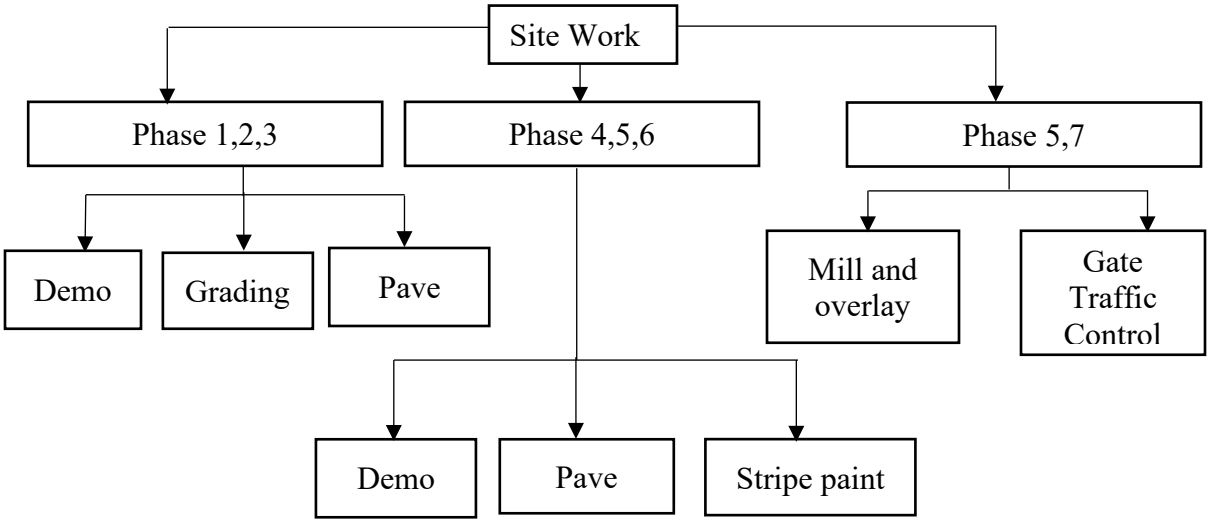

Figure 1. Project WBS

2. Methods

The work site was divided into different phases as a part of the plan which helped to minimize the effect of construction work on the occupant of the facility. This plan was designed to make sure that at any point of time there was minimum effect on the flow of traffic. At least one entrance and exit lane was left open for the traffic which was marked by posted signs and/or arrows to minimize confusion. The WBS also shows the type of construction activity planned for the phase. This helped to make sure all the necessary equipment were available before starting work on that part of

the facility. According to the specifications of the project phase 1,2,3,4, and part of phase 5 were to be demolished completely. After the demolition, the condition of the base course had to be examined and replaced if needed before placing the new pavement. Phase 7 and part of phase 5 however had to be milled and overlayed instead of complete demolition. The existing asphalt pavement was to be taken off site and can be recycled in small batches. The recycled asphalt pavement (RAP) material can be fractioned, separated, or screened to obtain the desired gradation and incorporate maximum amount of RAP in the mix (Shrum 2010). Recycling of the asphalt pavement is economically beneficial and an environmentally friendly approach.

Safety is another important factor that had to be considered as a part of the integrated project plan. Operation of very large equipment in a high traffic area needs to be coordinated carefully. A spotter was required to direct the driver when moving large loads or backing up a large machinery. There were people walking around the facility, so it was very important to be aware of the surrounding and stop any demolition work if someone was close to the equipment. Construction area had to be barricaded and taped off, and anyone present within this area was required to wear the proper PPE. All necessary PPE should be readily available before performing any work. Some of the PPE's required for this project included hard hat, eye protection, gloves, high visibility vest, and special mask if grinding or cutting was performed. Proper care should be taken during the demolition to not damage any existing features that are not included in the scope of work. It was decided that safety meeting would take place every morning before beginning the work. This would help to remind everyone the safety regulations that were in place especially if there was someone new working on the site. It is inevitable to have some changes in the plan along the way. It was decided that any change in the plan must be approved by the facility before it could be implemented. The responsibility of the field engineer was to effectively communicate any change in the plan between the contractors and the facility as soon as possible to avoid any delay in the project. The payment plan for the project was based on the amount of work completed. After having a good plan in place, the next step was to begin the construction work.

3. Data Collection

Construction work began with the demolition of phase 1 area. The specification called for the complete demolition of the existing pavement, grading and compaction of the base course and lay down a new pavement. After the demo of the existing pavement, it was found that the base under the existing pavement was a cement treated base (CTB). This was one of the unforeseen circumstances that came up during the project. The specification and plan had to be changed to address this newly found base. A RFI was sent out by the contractor to the project engineer to address this new development. After extensive research in this issue, decision was made to use the fiberglass grid in the areas with cement treated base. This new development created a delay in the project schedule since it took some time to come up with a solution and getting approval from the higher management. Although this unexpected problem caused some delay in the project, there was a great lesson to be learned from this experience. This issue could have been avoided by performing an exploratory core drilling during the design phase of the project. By performing an exploratory drilling, one can easily find the type of base course under the pavement without having to demo the whole area and then finding it out. This way all the necessary research and planning could be completed in time before doing any demolition. Using glass grid was a significant change in the scope of the work for the project. So, a change order was created to accommodate this plan into the scope of work.

As a result of this change order, 10% of the total budget was increased. The design of the project was modified to include glass grid in the high traffic areas with CTB under the existing pavement. Even after the new design was approved, the project couldn't start until the fiberglass grid was on site. The lead time on the glass grid was a week after which the paving of phase 1 started. To delay emergence and extension of reflection cracks in asphalt pavements, advanced countries such as America, Britain, Germany, and Canada started to prevent reflection crack with geotextiles at the end of the last century and have achieved effect of different degrees (Qian et al. 2020).

During the paving process, the truck carrying the hot asphalt mix backs up to the front of the paver and dumps the hot mix onto the paver hopper, it relies on the paver to push forward as required. When using the glass grid, one layer of asphalt had to be laid out and compacted then the glass grid was placed on top which was tack coated and then the second lift of asphalt was placed on top of it. Both lifts of asphalt had to be compacted following the specification. The tack coat is an adhesive between the base course and the fiberglass grid paving mat, it is waterproofing and can enhance shear strength of the asphalt complex, maintaining the synergy stability of pavement structure (Jin et al. 2019). If the glass grid was not placed the new pavement would be more susceptible to premature cracking because of the solid base underneath. This layer of glass grid provided the flexibility between the two layers and prevent it from cracking due to different weather or traffic conditions. The addition of fiberglass grid can effectively limit the

displacement and deformation of particles in the asphalt concrete, improve the tensile strength of the material, this reduces the possibility of cracks due to stress concentration (Ni et al., 2021). Table 2 shows the specifications used for the FAA ARTCC parking lot replacement project:

Table 2. Project Specifications

Task	Specification
Sub grade compaction	>95%
Base course compaction	>95%
Hot mix spread temperature	> 160-degree F
Initial Compaction temperature	> 155-degree F
Finished rolling temperature	>110-degree F
Weather	No rain, 40-degree F – 95-degree F

4. Results and Discussion

After phase 1 was completed, construction work was started in phase 2 area which had mostly base course under the pavement and a small section of phase 2 had cement treated base. Existing pavement was demolished completely, and the new base course was placed as needed. The base course was then graded for proper drainage and compacted according to the specification. Paving was done in two lifts as the glass grid had to be placed in the area where two different base type (CTB and base course) join. The scope of the work also included the erosion control work around the phase 2 area. Basically, a retaining wall with a sloped geo grid was constructed to control erosion in the area. Geo grid and the retaining wall prevented the soil from this area to be carried along with the rainwater into the storm drain. After completing phase 2 work, construction began in the phase 3 area. Although this area had less human and vehicle traffic flow compared to other areas, extra precaution had to be taken while working around the critical equipment. Instead of using large machines, small hand operated machinery had to be used around the corners. This area was milled about 3 inches deep and then overlaid with the new pavement. Hand operated compactor was used to compact the hot mix in this area. Since this area was very close to the control room, extra effort had to be put into minimizing the vibration and noise.

Next step on the plan was to demo the phase 4 area where construction work began shortly after completing phase 3 cleanup. The existing pavement was completely busted out and the base course was replaced. During the compaction and grading of the new base course an unexpected problem was found. During the compaction, it was found that there were some spongy wet spots in the area. These spots are found in the area where there is higher moisture content. Field instruction to resolve this issue was to dig up the sub grade in those areas and fill it with new subgrade and compact it. Initially this approach seemed to be the most efficient and quick solution to problem. There were only three of these spots present in this area which did not look like a big problem at the time. After fixing those areas, more compaction was done, and as a result more of those spots started to pop up. This was not a small issue anymore, so more investigation had to be done on this issue.

It was very important to find the source of extra moisture in this area and eliminate it because this would make it very hard to reach the desired compaction density on wet surface. If the base course is not compacted to the specification, then there will be a risk of premature cracking in the new pavement. One of the old drawings of the facility was showing that an abandoned 6-inch PVC sewer line was running through that area. That sewer line was dug up to see if that was the source of moisture in the area. After examining the excavated area and pipe it was found that the sewer line was not the source of water in that area. Another assumption was made that these spots might be located where there were big cracks in the existing pavement. The water could be running through the cracks and into the sub grade underneath. Since these wet spots started popping up everywhere, that assumption was also proven incorrect.

After testing the soil sample taken from this area, it was found that the reason for these wet spots was the presence of clay which socks up more water, hence creating those damp spongy spot. Clay minerals coating aggregates can prevent asphalt binders from thoroughly bonding to the surface of aggregate particles, increasing the potential for water damage to the paving mixture (US FAA 2000). As a solution to this issue the decision was made to put geo grid in this area. The geo grid was placed about 3 ft deep and covered with the new sub grade and base course. This approach helped to reach the desired compaction required by the specification. Then 4 inches of new pavement was laid down

in this area. The new pavement was left to settle down for one day and the next day the area was striped as shown in the drawing. Two ADA ramps were built in this area and the ADA parking sign was striped following the regulation. Construction began in the phase 5 area which included the southwest parking lot and the main driveway. Half of the driveway was demolished to keep the one-way traffic flow to the facility. The parking lot and half of the driveway was demolished completely. The southwest parking lot was graded, compacted and tack coated without any issue. After the new pavement was set, striping was placed in the area as shown in the drawing. There was a storm drain line running through the corner of the driveway which was having issues of overflowing when it rained. This storm drain was cleaned and scoped to see if there was any issue in the drain line that could be causing the overflow. The report from scoping the drain line showed that there was a pipe which was only 8 inches and runs between two manholes. This pipe was supposed to be 24 inches instead of 8 inches and it was shown in the facility drawing that the pipe was 24 inches. This was the reason for the overflow of the water through the manholes when it rained. This 8-inch pipe was connected to 24 inches pipe and couldn't keep up the flow coming from the bigger pipe. A RFI was sent out to with all the details to the project engineer.

The driveway could not be paved before this issue was resolved because if the drain line was going to be replaced then the new pavement had to be demolished. Replacement of the drain line was not included in the scope of the work. A change order was created to include this work as a part of the scope of work for this project. The 8-inch drainpipe was demoed and replaced with the 24-inch pipe which would solve the issue of overflow. Then the first half of the driveway was paved in two lifts with the glass grid placed in between the 2 layers of asphalt. Then the remaining half of the driveway was demoed and paved in the same way as the first half. Then the construction work moved to phase 6 which also had CTB under the existing pavement.

The pavement was demoed and the CTB base was cleaned, and tack coated. The glass grid required in this area was already on site and like phase 1 two lifts of asphalt was paved in this are with the glass grid placed in between the two layers. The new pavement was compacted and left to set for a day. Next day the parking spots and the cross walk was striped in this area. Phase 7 was more challenging and needed more coordination than the other areas. The main entrance and exit were a part of this area and there was no other alternate entrance/exit. The plan was made to work on one side at a time and use the other side as both entrance and exit. Since this was a secured facility, the guards at the gate had to check ID card of the people getting into the facility. Using the same gate as entrance and exit was a bit challenging and confusing so the work was scheduled to be performed during the weekend when there was least traffic flow. The work in this area started early and everyone had to work long hours to get the job finished before the week started. There were some areas in phase 7 that were supposed to be milled. There were signs of reflective cracking present in these areas.

The propagation of existing cracks from the old or existing pavement layer into the new overlay is called reflective cracking (Lytton, 1989). These areas had to be demoed completely and lay down the new pavement instead of milling. Reflective cracking is a major type of distress influencing the life of an overlay (Dempsey 2002). Reflective cracking in the overlay allows water to percolate into pavement structure and weaken subbase, and contributes to many forms of pavement deterioration, including increased roughness and spalling (Amini 2021). The scope of work also included some concrete work like replacing damaged curb and gutter as needed. A slump test was done by taking samples of fresh concrete from each truck load. A frustum of a cone is filled with concrete in a specified way and the slump cone is then lifted and the concrete allowed to collapse under its own weight. The difference between the height of the slump cone and the height of the collapsed concrete is measured which is called the slump value (Tattersall and Banfill, 1983). Concrete sleeves around the manholes were also demoed and replaced during the project. The weather condition must be within the specified limit when performing the concrete work. Concrete work should not be performed when the air temperature has fallen to, or is expected to fall below, 40-degree F (ACI 1967). There were some damaged sidewalks that had to be replaced and most of the curbs had to be painted as the part of the project.

4.1 Numerical Results

The numerical analysis and results from this project consisted of a variety of cored samples that allowed for up to 20% of RAP in the mixture design, whereas the milling increases the maximum RAP content to 30%, and stockpile mixing further increases the allowed RAP content to 40% (Zaumanis et al., 2018). For phase 4,5, and 6 after the pavement was placed, parking stripes had to be painted as marked in the drawing. Milling with a large milling machine was not possible around the utility equipment. Before starting the demolition, it was important to make sure a smaller milling machine was available to perform work in the narrow areas. A huge amount of dust gets generated during the demolition process which is why there should be a good dust control plan in place to minimize the amount of dust in

the work area. One important thing to remember was not to let any dust get inside the building through the outside air intake. The outside air intakes had to be turned off if there was going to be any dust generated around them. If the dust gets inside the building through the intake, it can degrade the indoor air quality. Turning off any equipment in the facility needs to be coordinated with the facility manager. Good communication is very helpful to make sure there are no interruptions to the facility operation. Another good approach to dust control was using a water truck to spray water in the work area frequently which minimizes the amount of dust generated. Scheduling is a very important PM tool that can be used to keep track of a project. A timely updated schedule helps to identify how many tasks have been completed and how much resources have been used in the project. Plan was made to schedule three weeks of work in advance so that the work scheduled can be discussed in the weekly update meeting. Table 1 shows a typical 3 week lookahead for the project:

Table 1. Typical Three - Week Schedule

ACTIVITY	SUB(S)	MSTR SCHED DATES	8/23 M	8/24 T	8/25 W	8/26 Th	8/27 F	8/28 Sa	8/29 Su	8/30 M	8/31 T	9/1 W	9/2 Th	9/3 F	9/4 Sa	9/5 Su	9/6 M	9/7 T	9/8 W	9/9 Th	9/10 F
Area 2 - East Side Parking Lot																					
Monday Safety / QC Brief	MANSCo		X																		
Retaining Wall	MANSCo		X	X	X																
Move Facility Material Lockers	MANSCo			X																	
Subgrade Prep	MANSCo		X	X													L				
Subgrade Testing	MANSCo			X													A				
Milling Phase 2	MANSCo			X	X	X											B				
Milling Stockpile for owner	MANSCo			X	X	X											O				
Base Course East Side Parking Lot	MANSCo			X	X	X											R				
Density Testing Base Course	MANSCo				X	X															
Prime oil	MANSCo						X										D				
Concrete Curb Removal	MANSCo					X											A				
Concrete Curb Replacement	LC Concrete						X	X									Y				
Asphalt Paving (1st lift east side parking lot)	MANSCo									X											
Tack oil	AUI										X										
Asphalt Paving (2nd Lift & Overlay on East Side)	AUI											X	X								
Phase 2 Striping	SAN BAR													X			L				
Phase 2 Owner Walk	FAA/Parsons													X			A				
Phase 2 Owner Turnover	MANSCo													X			B				
																	O				
All PHASES	**ALL Trades**																R				
Exploaratory Removals	MANSCo			X	X																
																	D				
PHASE 1																	A				
Concrete Demo (ramp #2 phase 1)	MANSCo		X														Y				
Curb & Ramp Subgrade Prep	MANSCo		X																		
Concrete Forming	MANSCo			X	X	X															
Concrete Placement	LC Concrete						X	X													
																	L				
PHASE 3																	A				
Safety /QC Briefing	MANSCo																B	X			
Asphalt Removals	MANSCo																O	X	X		
Concrete Removals	MANSCo																R	X			
Curb Subgrade Prep	MANSCo																		X	X	
Curb Subgrade Densities	MANSCo																D			X	
Curb Replacement	LC Concrete																A				X
																	Y				

4.2 Proposed Improvements

This project was completed for an ARTCC, and similar projects are scheduled to be done in many other ARTCC's. The lesson learned from this project can be easily used in other locations since the ARTCC's are designed to be identical to each other. One important recommendation from the project is to perform a core drilling to find the type of base under the existing pavement. If possible, take some soil samples from different locations of the work area and analyze the report for any unexpected situations. These steps should be done before beginning the construction work to prevent any delays. Investigate any existing issues like drainage and design changes before starting the construction.

4.3 Validation

After the project work was completed, a Joint Acceptance Inspection was scheduled. During this inspection key stakeholders from both government and contractor side get together and do a walkthrough around the work area. During this walkthrough, a punch list is made to note any deficiencies in the completed work. Quality of the work completed is checked and inspection is done for any damage to the existing features that was not covered by the scope of work. There were some minor and few major issues found during the inspection. Locations where the curb and gutter were replaced had some damages on the sidewalk which had to be fixed. In some areas there was a gap between the new curb and the existing sidewalk. This gap had to be sealed by using caulk to prevent water from getting inside and causing more damages. The corner walls of the buildings and bollards had to be cleaned and painted since they got dirty from spraying of tack coat and spreading the hot mix. Some of the newly poured concrete on the manholes

were starting to crack, these concrete sleeves had to be demoed and replaced. A flood test was performed to test the drainage of the water in new pavement. There was some insignificant ponding of water found in different locations which was not included in the punch list. But one location in phase 3 had a huge ponding of water during the flood test. This was a major issue and had to be fixed before closing out the project. About 20 sq. ft of the pavement in this area was milled and repaved. The grading of new pavement was carefully observed and as a result the issue of ponding was resolved. There were some rough surfaces mostly in the seam where two runs of asphalt came together. These spots were burned and coated with gator pave for smooth finish. In phase 5 area parking spaces were shown to be 10 ft wide in the drawing but the striped parking spaces were only 9ft wide. These parking spots were pressure washed and new striping was painted with 10 ft wide parking spaces. Most of the manhole covers were covered with tack coat and asphalt which had to be cleaned off. After all the deficiencies listed in the punch list were fixed, the project was closed out and both parties signed off on the closing documents.

5. Conclusion

It can be concluded from the study that the principles of PM used during each step of the project life were very helpful in the successful completion of the project. A team of qualified individuals having proper planning and resources in place were able to achieve the project goal successfully. These principles of PM can be used on any type of project but in the case of this construction projects it could've been the deciding factor in whether the project was deemed a success or a failure. It is important to formulate ideas and communicate them with other team members. Having a documented plan can help move the project in the right direction as this plan can be effectively communicated and the goals and objectives are easily identifiable. The study made it clear that the objectives can and will change during the life of the project. The goal should be to follow the plan as close as possible with the knowledge that adjustments will be made. This research suggests that when considering any changes to the objectives, this change should be analyzed and discussed on how it will affect the overall success of the project. This study also recognizes the value of each member of the team and the importance of teamwork in obtaining the projects goals. With the successful application of project management techniques, any project can be orchestrated flawlessly and with high standards.

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