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Resource Leveling for a Mass Digitization Project

Introduction

In 2011, University Library was awarded a grant from the National Historical Publication and Records Commission to digitize eight series of records from the Professional Air Traffic Controllers Organization (PATCO). These records included documents, memoranda, correspondence, meeting notes, voting records, office management files, benefits files, financial records, and collective labor agreements –comprising approximately 80 linear feet of archival material, 179,000 scans. The collection provided insight into air traffic safety, collective bargaining, salary negotiations, controller burnout, pension negotiations, and the 1981 strike in the United States.

This mass digitization project would include extracting the descriptive metadata from the existing encoded archival description (EAD) for the collection and uploading resources accessible online through digital collection management software (CONTENTdm). Access and discovery would be improved by linking to these objects in CONTENTdm from online finding aids. While the Special Collections and Archives Department of the Library had previous experience creating online collections, this would be the first mass digitization project undertaken by the Library. The immediate project team consisted of a project manager , a project archivist , two LTAs (Library Technical Assistants) and two student assistants. The project was slated to take 20 months for completion.

Resource leveling in can be utilized in grant-funded mass digitization projects like this case study where time, cost and available resources--the elements of the scope triangle (Figure 1)--are in tension with each other to define the scope and quality of a project. Resource leveling takes many shapes: identifying and using slack time, further deconstructing activities,

strategically adding more resources to the project (smoothing) and alternative scheduling. In the course of this mass digitization project several of these techniques were applied to keep the project on track. This paper explores these concepts and how their implementation facilitated this project's management and workflows.

Why is this important?

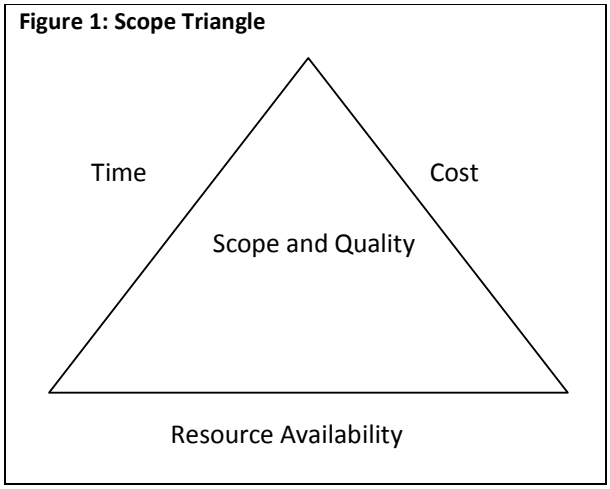

Figure 1: Scope Triangle

Digitization projects are being implemented in all types of libraries and cultural heritage organizations as the process of digitizing unique holdings and making them accessible to the research communities becomes a commonly held goal for these organizations. Neal writes that the interest in enabling access to unique, local collections will be paramount for libraries as they "increasingly focus on distinctive and unique collections in service to regional and national scholarly audiences." (Neal, 2011 p69) Data supporting this trend comes from OCLC Research which reports that 97% of the 169 libraries surveyed (institutions from ARL, CARL, IRLA, RLG Partnership, and the Oberlin Group) have "completed one or more digitization projects and/or have an active program" (Dooley & Luce, 2010) –-a significant increase from previous years in the number of organizations reporting this activity.

Northam (1999), de Vries (2009), Erway (2011) among others, have described some projects initiated in libraries and organizations of all sizes, in the U. S. and worldwide, where digitization of collections has been taken on, even with minimal budgets. As smaller-sized organizations initiate digitization projects, their managers will need to apply effective project management techniques to make the best use of limited available resources. Many of them

will undoubtedly have to manage larger or more complex projects with fewer people, less equipment than optimal and will need to be effective at scheduling within those limitations in order to complete projects on time and within budget.

Literature review

Project management skills are frequently cited in the literature of library and information sciences and archival studies as important to library managers (Revels, 2010; Kennedy, 2005; Sykes, 2008), and project management concepts are often referenced in articles outlining the management of digital projects (Middleton, 1999; Verheusen, 2008; Zarndt, 2011). However, utilizing project management processes for digitization projects is frequently discussed in very unspecific terms, without a close examination of the concepts and the relationship of the concept or strategy to the project at hand is sometimes not clear. Revels (2010) in *Managing Digital Projects*, examines the process of project management in libraries, describes the need for these skills and describes the phases of projects in the most general sense, but does not directly relate these concepts to specific digital project activities. Verhuensen (2008) describes mass digitization programs at the Koninklijke Bibliotheek and notes how project management became "a more important issue" for them but does not explain how the project management skills of managers assisted with the organization, quality and efficiency of the projects—the main topic of the paper. While Lopatin (2006) cites how vital project management is to the digitization process, for the projects she cites as using project management techniques the use of project management techniques is described in very general terms.

Cervone's series on project management which appeared in *OCLC Systems and Services* over several years covers general topics in project management as they relate to digital projects and offered some in depth discussion of project management techniques, including decision making and consensus building, risk management, and the life cycle of digital projects.

(2005, 2007, 2009) Middleton (1999) offers an outline of the process for digitization procedures using a project management approach, but does not discuss specific project management techniques such as resource leveling. While the consensus is that project management is central to completing successful digitization projects, many project management concepts which could be employed to improve the efficiency of digitization projects are yet to be closely examined in the literature. Scheduling, a concept which is closely related to resource leveling, is tacitly covered in many articles about project management, but there are as yet no studies which specifically target resource leveling for digitization projects. This case study focuses on the concept of resource leveling, how it was applied to a mass digitization project, and, more specifically how effective resource leveling helped keep the project on track.

Resource Leveling in Project Management

In traditional project management, resource leveling translates into effective scheduling or "a process that the project manager follows to schedule how each resource is allocated to activities in order to accomplish the work within the schedule start and finish dates of the activity." (Wysocki & McGary, 2003, p145) For project managers (PMs), the term "resources" frequently refers to people, but they may also be any of the tools, materials, facilities, and money that are needed to complete a project.

The scheduling of these resources involves identifying project activities, breaking them into finely defined activities, developing a work breakdown structure, and establishing a project network diagram. While these processes are core to project management, what follows is only a brief overview that attempts to provide a context for the discussion of resource leveling in our project within the framework of traditional project management. . A thorough discussion of developing a project network diagram and work breakdown may be

found in the resources for further reading on traditional project management concepts and processes which are provided in a separate section at the end of the text.

A project is defined in traditional project management style with a clearly stated scope and a project overview statement--this information marks the limits of the project, its objectives and success criteria, and identifies possible risks or obstacles. With this information, a project team can

1) Identify activities which must be completed to complete the project

2) Break activities into a hierarchy, made up of specific tasks and estimate time and resources needed for each. This creates a work breakdown structure (WBS). In traditional project management, there are a variety of approaches to creating the WBS: from top down (from project team leaders down), from bottom up (project team members or participants up), in subgroups or using the whole team through a brainstorming session.

3) Tasks make up activities and activities are 1-measurable, 2-have a definite start and finish dates, 3- have a deliverable, and 4- have a time and cost estimate. Activities are broken down to acceptable limits for the project and work assignments are independent. (The process of breaking down activities or decomposing them to an even finer, more granular level will be revisited in the discussion of leveling strategies.)

4) The relationships, or dependencies, that exist between activities are identified and described by the project team. There are 4 types of dependencies (Table 1): 1-Finish-to-start dependency where Activity B cannot start until the end of Activity A; 2- Start-to-start where activity B can begin once A begins; 3- Start-to-finish, Activity B cannot be finished sooner than Activity A has started; and, 4- Finish-to-finish, when Activity B cannot finish until Activity A finishes.[1]

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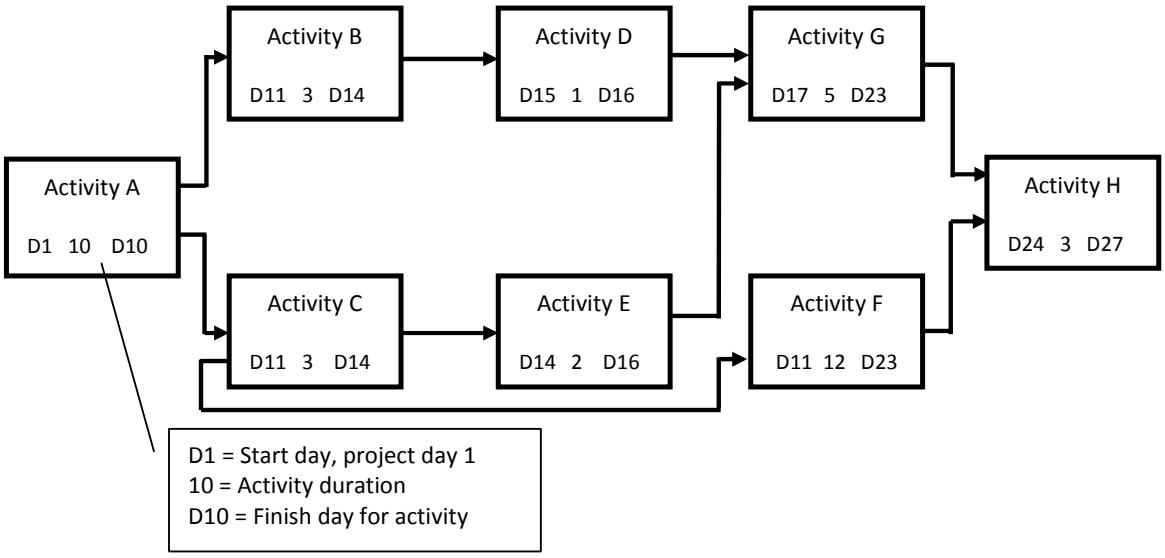
[1] Further description and discussion of dependencies can be found in any traditional project management text like those suggested at the end of the References section.

Table 1 Task Dependencies

A → B	Finish / Start When A finishes, B can start
A → B	Finish / Finish When A finishes, B can finish
A → B	Start / Start When A starts, B can start
A → B	Start / Finish When A starts, B can finish

5) Activities are chunked and usually the project team would agree on the first 2nd and 3rd level of activities. Having identified the information above about activities, the project team would develop a visual representation of the project of the WBS, which can be represented as an outline or a chart. Often this visual layout of the sequence of activities and their direction, duration and start and end dates is referred to a project network diagram, or it can take the form of a Gantt chart like the one in Figure 2. as one way to show the work to be done and the schedule for completing it as outlined in the work breakdown structure.

Figure 2 Gantt Chart for a typical project



Gantt charts illustrate the earliest start, the latest finish times for a project and the relationship, length and duration of the activities of the project. They also help project managers identify the project's *critical path*: the order or sequence of activities, the longest (and the shortest) time frame a project will take, and what must be done with the least amount of slack or delay time.

In the Gantt chart-like representation for a typical project (Figure 2), the boxes on the chart represent an activity and the length corresponds to the estimated time it will take to complete the activity, the start date, days scheduled for the activity and the end dates are also shown in that order in the bottom of the box. (Wysocki & McGary 2003, p89). The directional arrows indicate the dependency relationships, or which tasks need to be completed in what order or in tandem with other tasks. Figure 1 shows a process which is predominantly linear, with a clear progression of activities, with some activities occurring in tandem with others and completed at a corresponding time.

Following the WBS, thePM manages the tension between the project schedule and the available resources or people allocated to work on a project, assuring that task assignments to project staff are consistent and that the work effort is fairly constant over time. A well-developed, thorough and thoughtful WBS can help avoid the events that can forestall or stop a project. Nevertheless, there are times, even with planning and a WBS in place, when unexpected setbacks push a project off course and off schedule.

Resource leveling techniques used by PMs generally come into play when unexpected or unanticipated events occur. Using these techniques, PMs can adjust how each resource is allocated to project activities. While not a substitute for a well-crafted WBS and good project planning, resource leveling gives the project manager a means to respond to interruptions, under-allocation of resources, setbacks or delays once they have occurred.

One resource leveling technique is to identify *slack* or extra time that is built into part of the project timeline which, if used, will not impact the start of other activities or the project completion time. A PM might initially look for slack time in the WBS and become adept in finding and using slack to relieve the over use of other project resources by rescheduling or reordering activities.

PMs might also shift the project deadline or ask for a delay of the project deadline in order to ease a tight schedule and make resource allocation more feasible. Allocating additional resources or the use of substitutions or temporary workers, perhaps from other projects is another way which might improve a project schedule.

Schedules can also be improved by making *activities independent*--separating out the specific tasks within activities in order to divide them among other staff who may be available. This kind of further *decomposition* of activities will sometimes relieve a scheduling issue by assigning work based on staff availability and allows tasks to be distributed, but also allows staff to easily work around other assigned or required tasks, functioning as a kind of fill-in activity.

Stretching work over a longer period is a technique usually employed to assist the continuity of resources and resource effort on a task. For example, a project member's work on a task for half day for 10 days equals 5 full effort days—so the activity could be stretched by assigning the project member to work on the activity for a quarter of a day for 20 days. With stretching, this also equals 5 full days of effort. (Wysocki & McGary, 2003)

Resource Leveling for PATCO

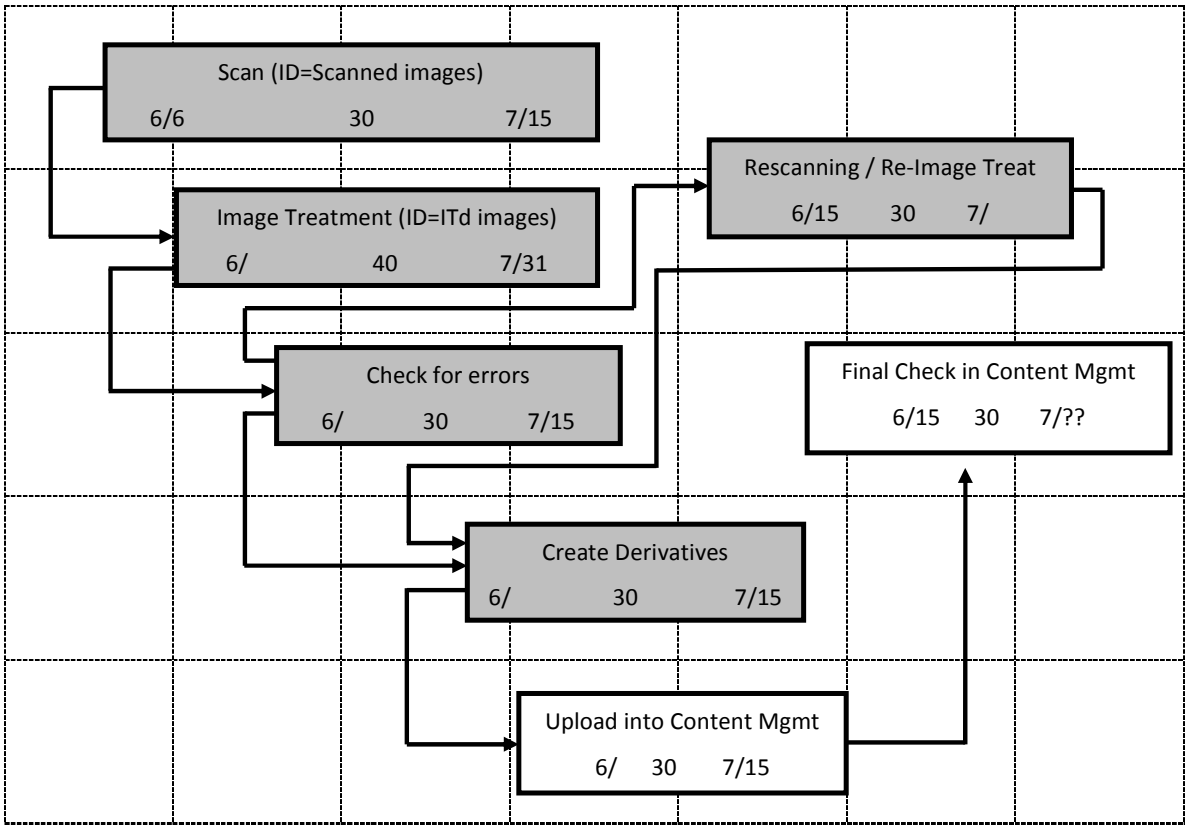
For the mass digitization project described here, using the techniques of shifting project deadlines or adding additional resources or were not options: the project deadline was set by an external funding agency and work would have to be completed within the available time and with the allotted funding. To accomplish resource leveling, the project manager and

project archivist instead focused on decomposition of assigned tasks along with creative scheduling of staff: both the decomposing some activities and stretching others were used together to relive the anticipated bottle neck in the workflow and a variety of creative schedules were used to augment the scheduled use of the scanner.

The Library's large-bed planetary scanner was purchased in 2009 and had been used to complete a smaller digitization project prior to beginning PATCO. This equipment was considered a robust, work-horse scanner, gauged to handle hundreds of thousands of scans and it was the only scanner in the library suitable for this project. The project grant funded one full-time technical –archival assistant and one to two student assistants. An additional technical assistant was assigned to the project as a 50% cost share contribution from the Library.

The scanner workstation software included OPUS© image handling software that archived and allowed for image correction, and created derivatives. Since all 179,000 images would be created and manipulated on this workstation, an immediate concern for the project team was the means and ability to manage the obvious bottleneck that would be created by having a single scanning station. Reviewers of the grant proposal commented on how "ambitious" the project was, going forward with a single scanner for such a large collection, hence the interest in effective project management, specifically the management of project resources.

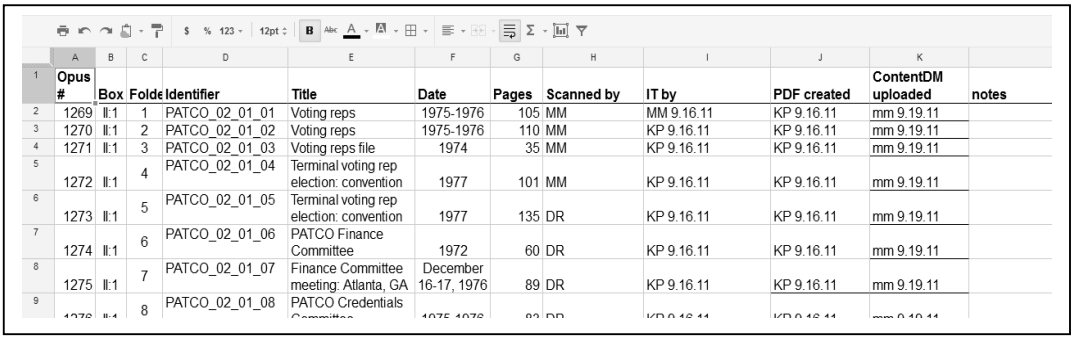
Figure 3 Gantt Chart for Digitization Project – 1 of 8 Series



The Gantt chart in Figure 2 depicts a typical project where a group of activities which are "finish-start" dependencies (when one activity finishes, the next one can start), in a linear order and stretched out over the time line. In contrast, the Gantt chart for our project in Figure 3 shows a very different kind of project. The chart reflects the process for one series, where the milestone is the completion of that series.

The various "start-start" dependencies (when one activity starts, the other can start) illustrate

Figure 4 Tracking Spreadsheet for Scanning Items



	A	B	C	D	E	F	G	H	I	J	K	
1	Opus #	Box	Folde	Identifier	Title	Date	Pages	Scanned by	IT by	PDF created	ContentDM uploaded	notes
2	1269	II:1	1	PATCO_02_01_01	Voting reps	1975-1976	105	MM	MM 9.16.11	KP 9.16.11	mm 9.19.11	
3	1270	II:1	2	PATCO_02_01_02	Voting reps	1975-1976	110	MM	KP 9.16.11	KP 9.16.11	mm 9.19.11	
4	1271	II:1	3	PATCO_02_01_03	Voting reps file	1974	35	MM	KP 9.16.11	KP 9.16.11	mm 9.19.11	
5	1272	II:1	4	PATCO_02_01_04	Terminal voting rep election: convention	1977	101	MM	KP 9.16.11	KP 9.16.11	mm 9.19.11	
6	1273	II:1	5	PATCO_02_01_05	Terminal voting rep election: convention	1977	135	DR	KP 9.16.11	KP 9.16.11	mm 9.19.11	
7	1274	II:1	6	PATCO_02_01_06	PATCO Finance Committee	1972	60	DR	KP 9.16.11	KP 9.16.11	mm 9.19.11	
8	1275	II:1	7	PATCO_02_01_07	Finance Committee meeting: Atlanta, GA	December 16-17, 1976	89	DR	KP 9.16.11	KP 9.16.11	mm 9.19.11	
9	1276	II:1	8	PATCO_02_01_08	PATCO Credentials Committee	1975-1976	83	DR	KP 9.16.11	KP 9.16.11	mm 9.19.11	

how the project tasks or activities do not have a linear start and finish, with one dependency following the next. Tasks / activity boxes are stacked or lined up for completion almost concurrently and reveal an almost horizontal order of completion. The boxes in gray on the chart also indicate those activities that require the use of the only available project scanner. This linear "stacking" of simultaneously occurring activities and the limited resource of a single scanner represent visually how immediate and severe this bottleneck was.

Further Decomposing Activities

The eight series of PATCO records to be scanned for this project consisted of 205 archival boxes containing 2510 folders. Migrating an object from scanning through image treatment to ingest into the content management system, documents were scanned on the OPUS© workstation, then image-treated while in the workstation PC using scanning software. For this discussion, the contents of a single collection folder represent a single object, which could range in size from a few pages to several hundred pages.

Most of the scanned object creation process ran in a more or less continuous workflow, driven by scanner software. The process did not rely on chunking or batching groups of objects with the smallest chunk or batch being a single object or a single folder. The scanner software tracked and handled the stages for each object: scan, image treat, create derivatives and archive. While these stages were driven by the requirements of the software, they were also managed by LTA staff, in tandem, who used a spreadsheet in Google Docs (Figure 4) to track and manage items going through the process. Spreadsheets also tracked exception items like rescans, re-image treatment, etc. Once the final derivative and archived copies were created, they were placed in a shared network drive, which was then matched with the metadata and migrated into the CMS.

A number of other mass digitization projects report using a tracking spreadsheet for quality control issues, like insuring that all folders were processed and accounted for or that additional processes have been completed (Torborg, 2008; Dixon, 2012). And also like other digitization projects, tracking spreadsheets in this project were color-coded to identify the progress of folders through the system—particularly for tracking which folders had been added to the content management system, which had not, and which had image treatment or other issues and had been sent back for correction were easily identified.

This and the processing stages of the software served to further decompose the continuous workflow of the scanning and image treatment activity and made it possible for more than one person to handle different parts of the process. An LTA or student assistant might scan a single object along with others in the morning and the scanner retained the object in the image treatment stage until later when that part could be completed by another project staff member, then moved into the final archive stage of the software. At the same time, objects are tracked on the spreadsheets as they progress. As both LTAs were trained to work together more or less synchronously, and as long as objects were tracked, it was possible for either LTA to pick up where the other left off. The final creation of derivatives and archiving could be done later.

Further decomposing activities in this way created tasks that were transferable and interchangeable, but also could be recombined as needed. Individual tasks could be put together to create a string of tasks to fit longer or shorter time slots or broken up to be distributed to more than one staff member. Since tasks were now more transferable this helped the project manager staff to fill in the blanks and make better use of available slack time.

An alternative to further decomposing activities for the single scanning station which was considered, but not implemented, was to adjust work flow to move pre-image treated scans

off the scanner workstation to another workstation and use alternative software packages, a combination of Photoshop and ABBYY© FineReader, etc., to create the derivative files and archive the original scans. This would have helped break some of the bottleneck created by having a single scanner, distributing the workload for image treatment and archiving, but only after the initial scanning stage. As the scheduling and resource leveling techniques used appeared to be moving the project at a better-than-acceptable pace and because the addition of a workstation and software would be a cost absorbed by the Library, this alternative workflow process was not pursued.

Alternative Scheduling as "Smoothing"

Smoothing typically refers to assigning or requiring work time in addition to the standard 40-hour work week for staff on a project, also called overtime. However, considering that the staff assigned to the project was fixed—the LTAs contributing 60 work hours per week, the student assistants contributing 40—there were adequate man hours or "effort" available to complete the work. The resource that needed to put in some overtime was the scanner. So, in order to augment the scheduled use of the scanner beyond the traditional 40-hours per week, staff schedules were staggered beyond the 8 am to 5 pm, Monday through Friday schedule window to include start times at 7 am, end times at 7 pm and weekend hours. This alternative scheduling added about 24 hours per week of effort in scanning, image treatment and final disposition of derivatives and archival files by staff.

An alternative schedule is impossible to implement without the buy-in and participation from project staff. Nevertheless, if in completing the WBS, a PM anticipates constraints or a bottleneck on a project, alternative scheduling may be a low-cost way to resolve the issue. Anticipating this, the PM could develop and write the plan of work, the workflow and position descriptions (and advertise and hire for positions) which require alternative work hours, outside the usual 8-5 schedule.

Project Setbacks and Current Status

Since its initiation this mass digitization project has encountered a number of setbacks, ranging from minor to substantial. During the project period, the Library migrated its digital collections to a preservation quality storage system, which halted the phases of work on our time-bound project as well as work on all digital collections. The implementation process and the migration of digital collections across storage systems created a delay of almost six weeks. Also, the upgrade of the current content management system, another infrastructure issue, was anticipated in the work plan, but was not expected to create a major work stoppage. In reality the upgrade created a number of programming issues and, though most issues were resolved as quickly as possible by the department's programmer, the process resulted in intermittent and ongoing delays in uploading completed objects into the collection.

Staff turnover also created delays. While the two LTAs hired at the start of the project have stayed on, the turnover for the student assistant positions has been steady, with most students working only about six months. Since students did most of the scanning work and their contributions to the work flow were essential, when scanning was slowed or stopped, the LTAs had to take on this work, in addition to their other work, in order to prevent a backlog. Also, having to re-advertise, interview, and train new personnel for this work was an additional and significant drain on project personnel's time.

Failure to account for the risks of staff turnover and collection migration to the project plan--undoubtedly lapses in project planning -- were nonetheless mitigated by effective resource leveling: despite sometimes significant delays, our mass digitization of the PATCO files has met or surpassed milestones within the plan of work to date. Project staff are on track to completing

their work in 2013, in time for the planned official launch of the collection. While resource leveling is only one factor that has contributed to the success of this project, and only one of the many techniques available to project managers, it has proven to be an essential and cost-effective method for keeping both the project scope boundaries and the project timeline intact.

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