PROJECT MILISTONES AND TASKS

1 Introduction

Milestone planning is a planning approach pioneered by Andersen (Andersen E. , 1996) and Turner (Turner, 2004) in which projects are planned in terms of their outcomes, the attainment of significant process states, external dates and customer commitments, instead of on the basis of the tasks to be performed. Milestone plans are more robust, comprehensive, easier to understand, and accept and confer great flexibility in terms of how to achieve the milestones, which makes them a very apt tool to be combined with agile approaches. According to both authors, milestone planning should be performed by the group, as "it is important that a sense of community develops around the plan" (Andersen, Grude, & Haug, 2009) and "developing the plan in a group session builds greater commitment than if the project manager develops it on his or her own and tries to impose it on the team" (Turner, 2004), but they do not offer a systematic method for how to do this. This paper address that gap by proposing a participatory and visual approach to construct milestone plans called the Visual Milestone Planning (VMP) Method.

While thinking and expressing a plan in terms of milestones rather than tasks certainly contributes to the plan's robustness, comprehensiveness, understandability and acceptability; these three properties are mainly the result of the how the plan is constructed and who is involved. Restating Turner's words, a milestone plan developed in isolation by a project manager and later communicated or simply handed down to those responsible for its implementation, would not be as comprehensive, understandable and acceptable as one developed with the participation of the team using visual techniques.

In the context of this paper, participatory planning, is a practice in which the people responsible for the execution of the plan is actively involved in its formulation. Successful examples of this way of working are numerous: the pull planning process in the “Last Planner System” used in the construction industry (Ballard, 2000) and “Blitz Planning” (Cockburn, 2004) and “Cards on the Wall” (Phillips, 2001) on software development to cite a few. The benefits of participation in the planning process are many: better and more comprehensive plans as consequence of the involvement of a mixture of people which brings different perspectives to the process, greater commitment as plans are talked through and advance the thinking of the group, the development of a common framework and vocabulary for decision making which extends well beyond the “high” of a successful planning session and an overall higher probability of success as people that participates in the shaping of the plan better understand the needs, the goals and where their responsibilities lay with regards of those of others (Moss Kanter, 1989).

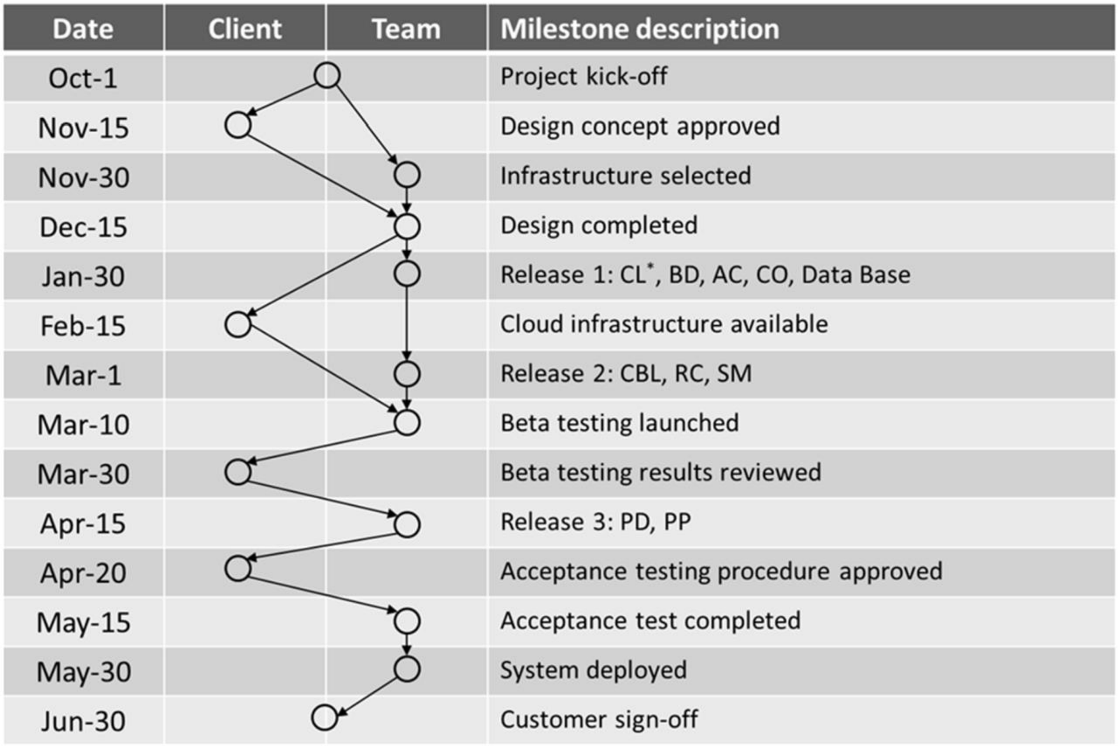
Visual planning is an approach by which a team plans its work and controls its progress through the use of physical representations of tasks in combination with frequent and interactive meetings. Visual planning provides cognitive, social and emotional benefits (Eppler & Platts, 2009). The cognitive benefits of visual representations include facilitating elicitation and synthesis of information, enabling new perspectives to allow better, more exhaustive comparisons and facilitating easier recall and sequencing; the social benefits include integrating different perspectives, assisting mutual understanding, and supporting coordination between people; and the emotional ones include bolstering involvement and engagement, providing inspiration, and aiding convincing communication. Visual planning variants are being used in a number of different contexts, e.g., lean product development (Lindlöf & Söderberg, 2011) and (Jurado, 2012) and construction projects (Tjell & Bosch-Sijtsema, 2003) among others.

VMP implements participatory and visual planning techniques through the reification of the planning constructs: work packages, milestones and schedules employed in the planning process and their direct manipulation by team members who collectively create the plan.

While the article will provide a cursory explanation of all artifacts and techniques mentioned in it in an effort to make it self-sufficient, the focus will be on the proposed method and the novel constructs employed. We encourage the interested reader to consult the original literature describing VMP’s constituent techniques. The rest of the paper is organized as follows: Section 2 describes milestone plans, Section 3 explains the proposed method, Section 4 provides a detailed example that illustrates the use of the method and serves as validation, Sections 5, the linkage of milestone plans to planning waves and iterations in agile projects and Section 6 an initial evaluation of the method.

2 Milestone plans

Andersen (Andersen E. , 1996) defines a milestone not “as the completion of an activity, usually an especially important one” but as “a result to be achieved, a description of a condition or a state that the project should reach by a certain point in time. A milestone describes what is to be fulfilled, not the method to fulfil it”. Figure 1 shows a typical milestone plan. As can be observed, a milestone plan is short, typically confined to a size which will allow it to be grasped at once and written using a vocabulary a project sponsor can understand. The plan comprises a sequence of states the project will go through, from its inception to its successful conclusion, and not the activities the team needs to perform to achieve those states. For example, the “Design concept approved” milestone, defines a state where the project team has presented an idea that satisfies the needs of the sponsor and he has acquiesced to it. The plan does not estipulate how the team will get there. Will they build



Date	Client	Team	Milestone description
Oct-1	○	○	Project kick-off
Nov-15	○		Design concept approved
Nov-30		○	Infrastructure selected
Dec-15		○	Design completed
Jan-30		○	Release 1: CL*, BD, AC, CO, Data Base
Feb-15	○		Cloud infrastructure available
Mar-1		○	Release 2: CBL, RC, SM
Mar-10		○	Beta testing launched
Mar-30	○		Beta testing results reviewed
Apr-15		○	Release 3: PD, PP
Apr-20	○		Acceptance testing procedure approved
May-15		○	Acceptance test completed
May-30		○	System deployed
Jun-30	○	○	Customer sign-off

Figure 1. A typical milestone plan showing due dates, responsibilities and milestones' descriptions

wireframe diagrams? Develop high fidelity prototypes? Make a PowerPoint presentation? Perform user testing? Employ focus groups? At some point, these issues will certainly have to be addressed by the team, but they have no place in a milestone plan.

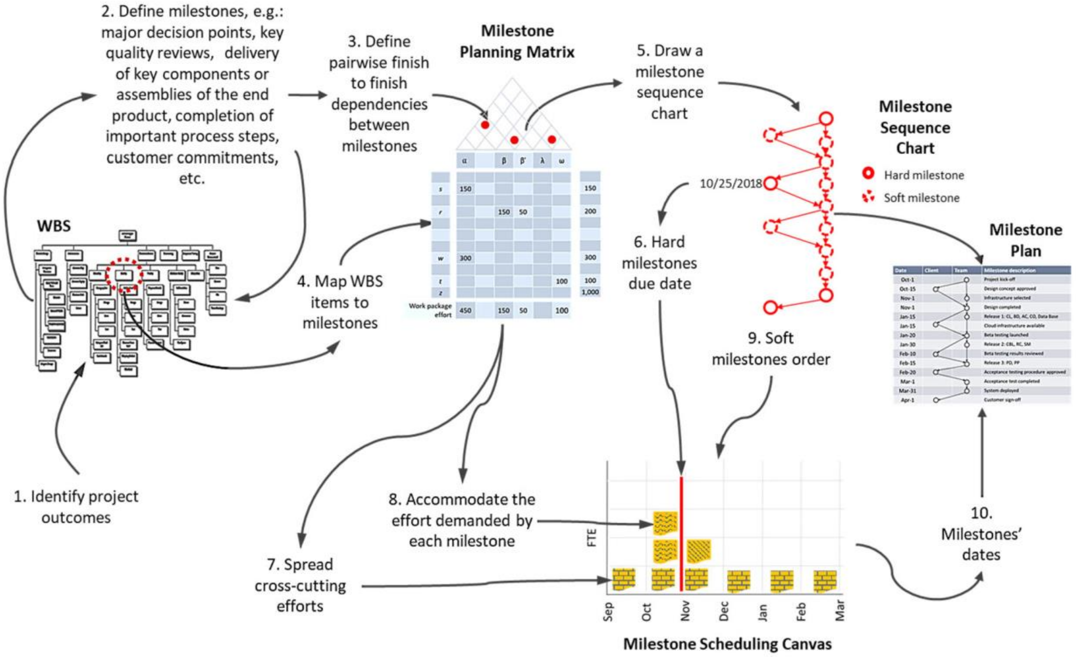
The focus on states rather than on activities results in a more robust plan since independent of what tasks are performed to get there, when and by whom, the project sponsor would like to approve the design concept before it is implemented and that is unlikely to change.

The dependencies between milestones are typically "Finish to Finish" relations, meaning that if "Milestone B" depends on "Milestone A", "Milestone B" cannot be completed until "Milestone A" has been completed. Finish to Finish relations are easy to spot and provide great freedom as to when the activities leading to the realization of the milestone could start.

Milestones could be hard or soft. Hard milestones are milestones, that if not accomplished by a set date, lose all or most of its value or results in severe penalties. The date a government resolution which the system under development is supposed to address goes into effect and the start of the holidays shopping season are examples of hard milestones a project might need to satisfy. Soft milestones on the other hand, have completion dates that result from the planning process. They might be associated with penalties or other liabilities after a statement of work is agreed, but in principle are discretionary.

3 The Visual Milestone Planning (VMP) Method

Figure 2 depicts the VMP Method. The first step in the process is to create an outcome oriented work breakdown structure (WBS) defining the project scope. Each WBS element will have associated with it the estimated effort required for its realization. These estimates will be later used to establish windows of opportunity in which the anticipated work could be performed. A project whose final outcome is not well defined could be scoped in terms of learning activities such as running a design sprint and planning packages that have a definite purpose and budget but whose exact content has not yet been decided.


2. Define milestones, e.g.: major decision points, key quality reviews, delivery of key components or assemblies of the end product, completion of important process steps, customer commitments, etc.
3. Define pairwise finish to finish dependencies between milestones
Milestone Planning Matrix
5. Draw a milestone sequence chart
Milestone Sequence Chart
Hard milestone
Soft milestone
10/25/2018
WBS
4. Map WBS items to milestones
α
β
β'
λ
ω
s
r
w
t
z
150
150
50
200
300
100
1,000
Work package effort
450
6. Hard milestones due date
Milestone Plan
1. Identify project outcomes
9. Soft milestones order
8. Accommodate the effort demanded by each milestone
7. Spread cross-cutting efforts
FTE
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Milestone Scheduling Canvas
10. Milestones' dates

Date	Client	Team	Milestone description
Oct-1		○	Project kick-off
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Feb-15		○	Release 3: PD, PP
Feb-20	○		Acceptance testing procedure approved
Mar-1		○	Acceptance test completed
Mar-31		○	System deployed
Apr-1	○		Customer sign-off

Figure 2 Participatory approach to milestone planning

The second step in the process is the definition of milestones. Milestones are chosen to signal the taking of a major decision, the delivery of key components or assemblies, the completion of important process steps or to mark a commitment made to the team, e.g. a customer makes proprietary equipment or technology required by the project available to it. Notice that in the diagram there are arrows back and forth between steps 1 and 2. This is so because although the WBS will normally inform the choice of milestones, sometimes the selection of a particular milestone might result in the creation of a new task or outcome that must be incorporated in the WBS or leads to its rearrangement.

In Step 3, the identified milestones are first written down from left to right as column labels in the header row of the milestone planning matrix, ordered according to a logical sequence of completion. Beware that in the presence of multiple paths through the project this sequence might not be unique. Finish-to-finish non-redundant pairwise dependencies between milestones are captured by placing a dot at the intersection of the diagonals corresponding to the related milestones in the roof section of the planning matrix. The roof of the matrix could then be used to unravel the list into a milestone diagram, Step 5, which communicates the milestone sequence in an easier to read format for the team to validate.

In step 4, the WBS elements are associated to the milestones they help realize via the body of the milestone planning matrix. The association is done by labelling a row in the planning matrix with the name of the top most WBS element whose descendants all contribute to the same milestone, and recording the effort required by it at the intersection of the said row and the column corresponding to the milestone with which the element is associated. A milestone can have multiple WBS elements associated with it, i.e. several WBS elements must be completed to realize the milestone. In most cases a WBS element would be associated with a single milestone, there are however a few instances, which will be discussed later, in which is convenient to allocate fractions of the total effort required by the WBS item to multiple milestones. The set of WBS elements associated with a milestone is called its work package.

In Step 6 we mark hard milestones in the scheduling canvas and black out non-working dates such as holidays or known vacation periods. Hard milestones will act as anchor points for the plan.

In steps 7, 8 & 9 we build the project's staffing curve by posting sticky notes on an empty space in the milestone scheduling canvas such as all effort required by a milestone's work package could be fitted to the left of it while respecting the milestones' order. As will be explained later, sticky notes reify the effort required by a work package. Each sticky note would correspond to a fixed number of person-hours of work with the horizontal edge of the note corresponding to a unit of time commensurate with the size of the project, e.g. week or month and the vertical edge corresponding to one full time equivalent resource. The physical dimensions of the sticky notes must match the scale of the milestone scheduling canvas axes.

Sticky notes cannot overlap as this would imply that a resource would be performing two tasks at the same time. The position of a work package's rightmost sticky note on the canvas indicates the earliest date by which the corresponding milestone could be completed. If somehow the plan is not feasible, e.g. there are not enough resources or the hard milestones dates cannot be met, the project scope should be renegotiated, the work approach reformulated or the constraints lifted.

In Step 10, we complete the plan by reading the due dates for all milestones from the milestone scheduling canvas, assigning responsibility for their realization and properly formatting them.

The outcome oriented work breakdown structure

An outcome oriented work breakdown structure (WBS), see Figure 3, also known as deliverable or product oriented WBS, is a hierarchical representation of all the work a project needs to do constructed using the project's results as main decomposition criteria.

The importance of accurately identifying the scope of work in a project cannot be overstated. Accurately does not mean we need to know every last detail at the beginning of the project. Accurately means that if there are things we think we ought to know, but at present we don't, we acknowledge them and make provisions to learn and perform the work with the understanding, that if things exceed our allocations, the plan will need to be revisited.

We prefer to call this type of WBS outcome and not deliverable or product oriented to force teams to think that a project could be expected to produce results that are not products, for example a project might be about organizational change, that is after the project is successfully concluded the organization performs at a new, higher level. We find useful thinking in terms of four types of outcomes a project might be expect to deliver: products, services, processes and capabilities. From the point of view of the WBS construction, all outcomes are treated the same.

An outcome oriented WBS will contain the expected project results and the activities necessary to realize them (National Aeronautics and Space Administration, 2007). The first level of the hierarchy defines a set of outcomes and activities that collectively and exclusively represent 100% of the project scope. Outcomes might be broken down into lower level outcomes and activities or tasks. Activities can only have other activities and tasks as descendants. Tasks are not decomposable. The convention used in building the WBS, is that integrative and common activities support all the WBS elements with the same ancestor and that, whenever and activity or task applies only to one element it should be subordinated to it.

Correctly positioning activities and tasks is critical to establishing the true effort/cost of producing a given WBS element. This is important because this information will be used to support scoping, staffing and scheduling decisions. For example, if an architectural activity supports the whole project it should be positioned at level 2 of the WBS, however if the system under planning is made up of a number of subsystems which could be implemented or not depending on the available funding or some other factor, each of them including significant architectural work we will include the subsystem's architectural activities under each of them, so in case a decision not to implement a subsystem is made, removing the subsystem from the WBS will also remove all the direct costs associated with it without affecting other parts of the WBS.

The Practice Standard for Work Breakdown Structures (Project Management Institute, 2006) defines two types of activities:

- Discrete Effort. Work effort that is separate, distinct, and related to the completion of specific work breakdown structure components and deliverables, and that can be directly planned and measured.
- Level of Effort (LOE). Support-type activity (e.g., seller or customer liaison, project cost accounting, project management, etc.), which does not produce definitive end products. It is generally characterized by a uniform rate of work performance over a period of time determined by the activities supported.

The distinction is important, because as will be explained later, it affects the way in which WBS elements are mapped to milestones.

Consistent with the idea of deferring the elaboration of the specific tasks to be performed to a later stage, a WBS to support milestone planning only requires decomposition of its elements for the purpose of:

- Making clear the scope of the project, e.g. what is the project expected to deliver
- Estimating the effort required by the project or a WBS while avoiding gaps and double counting for lack of specificity, i.e. avoid vague activities such as "develop" that do not communicate what is included or excluded from an estimate
- Supporting scoping, major scheduling and allocation decisions, e.g. we can do this but not that, we can do this now and that later, or we can do this and outsource that
- Help isolate riskier elements, e.g. elements that somehow should be treated differently
- Have to be separated for administrative or compliance reasons, e.g. CAPEX vs. OPEX, industrial benefits, etc.

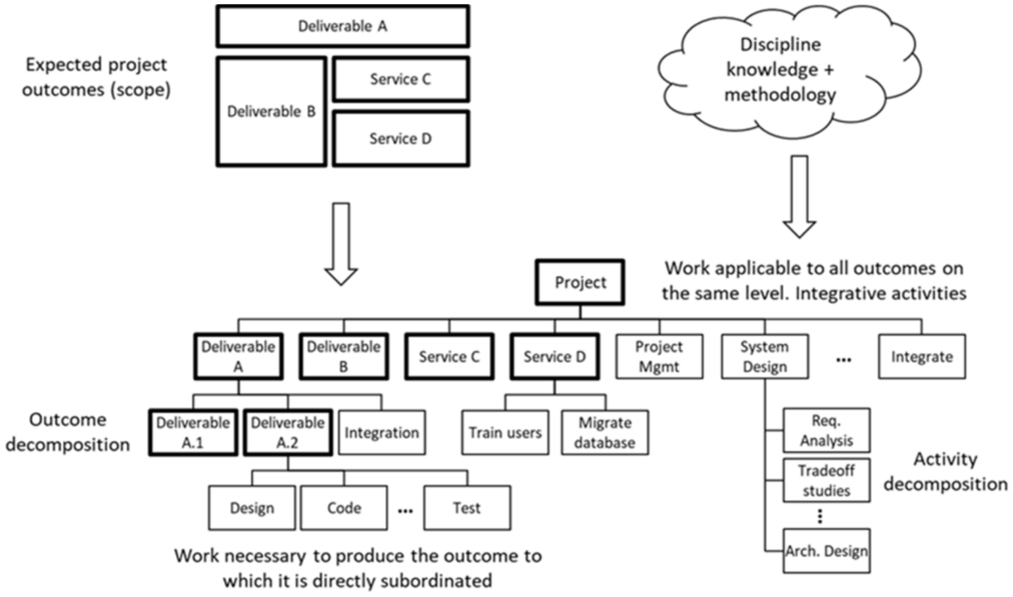


Figure 3 WBS example (Adapted from NASA's System Engineering Handbook, 2007)

The milestone list

Correctly identifying the set of milestones to include in the plan is essential to its acceptance as these would become the vocabulary that will be utilized to explain the work logic to the project sponsors and other team members as well as to gauge its progress. A good milestone set will include, as a minimum, the things the sponsors care about. For example, in a software development project, if the project sponsor wanted to have a review of the user interface before moving forward with the rest of the of the software, it would make sense the milestone set include a "UI Approved" milestone.

A milestone describes an event that needs to occur not later than a certain date at risk of delaying other milestones or the whole project. Typically, milestones will fall in one of three categories: the realization of an outcome, the attainment of a relevant project state or the satisfaction of a commitment made to the project team by an external party. The first two types of milestones are achieved upon the completion of all work items included in its work package. In the case of a commitment to the team, the milestone is achieved when the party responsible for it fulfils its obligation. These last milestones tend not to have a work package associated with it and are an excellent instrument to synchronize work across multiple teams, each working according to their own plan.

The following are examples of the different types of milestones:

- Outcomes: a document, a partial or total system capability, a prototype, the results of a survey
- Desired states: a major decision, an approval, an attainment of some kind, e.g. number of transactions per second, number of users trained
- Satisfaction of commitment: delivery of proprietary equipment necessary to test the software under development a special hardware is delivered to the project team, publication of an API specification by another team

The criteria by which to judge the realization of a milestone is known by different names in different contexts: exit criteria, definition of done and conditions of satisfaction but they are all about the same thing: having an objective test to determine whether the milestone has been reached or not.

Typically, a completion criterion would include the list of work items to be finished, a description of its state and, if applicable a quantity of items to be delivered, demonstrated performance such as transactions per second or power efficiency, and a definition about the quality those things need exhibit at, e.g. defects counts, tolerances, weight limits, power consumption levels, level of coverage, etc.

Many times writing the completion criteria will bring up or force the breaking down or the re-estimation of activities already on the WBS. This is a good thing because the early identification of these gaps helps prevent problems later in the project. Working on the definition of done also helps the team develop a shared understanding of the work to be performed.

The number of milestones chosen must balance visibility with robustness and ease of understanding. Depending on the size of the project 10 to 50 milestones will satisfy the needs of most small to midsize projects. Given the visual nature of the method every effort should be made to confine the plan to a size which allows to have it in sight at once.

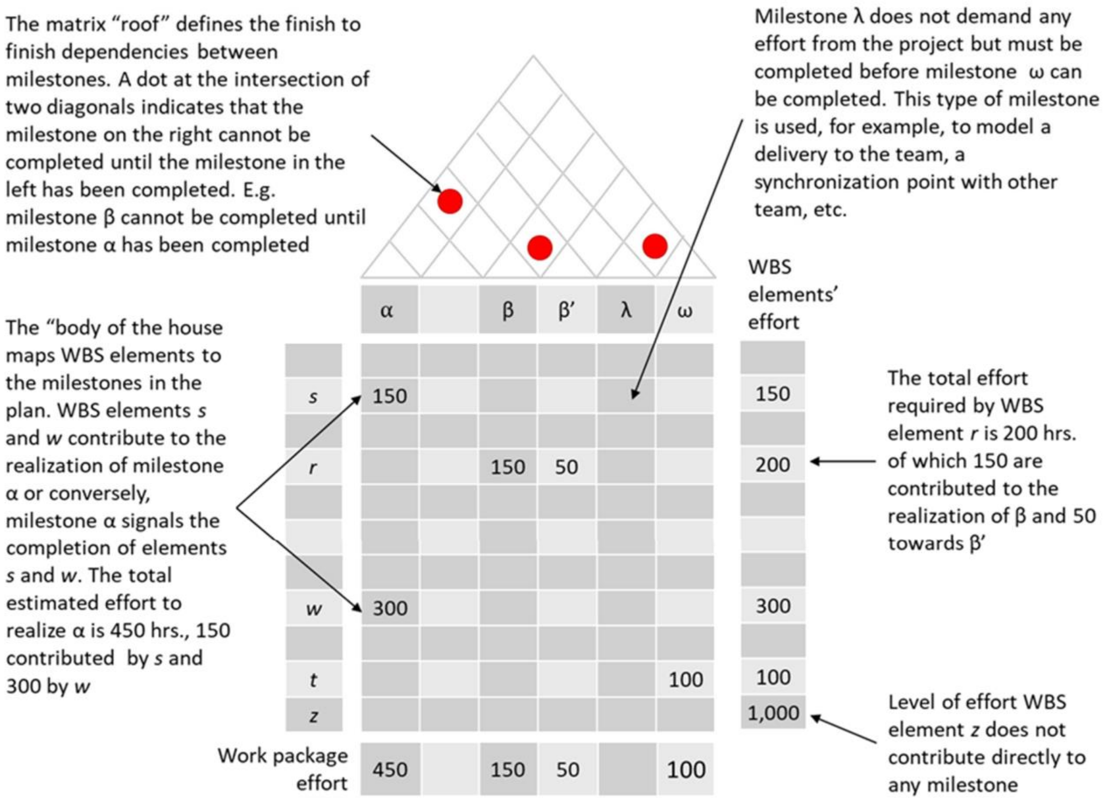
Once the milestones have been identified, the team will order them in the approximate sequence in which they must be completed.

Milestone planning matrix

The Milestone Planning Matrix (MPM), see Figure 4, resembles the matrix known as the "House of Quality" in the Quality Function Deployment method (Hauser & Clausing, 1988). Strictly speaking, the MPM is made up of two matrices: A triangular matrix[1], the roof of the house, which captures finish to finish dependencies among milestones and the body of the house, which is a multiple domain matrix (Maurer, 2007) (Browning, 2016), mapping work items in the WBS to the milestones they help realize. The beauty of the approach is that the construct provides a straightforward mechanism to make visible these relations to everybody involved in the planning process. Visibility is the key to prevent gaps and overlaps in the plan and in the development of a shared understanding by stakeholders.

[1] We propose the use of a triangular matrix because it provides a nice, compact and directly manipulable representation but other representations are possible if the triangular representation gets to complex. The author has experimented with Design Structure Matrices (DSM) and directly creating the Milestone Sequence Diagram

Most of the time, work elements will map naturally and on its entirety to a single milestone, but in practice the author has found some situations in which this is not the case. Two of the most common are level of effort activities and outcomes involving a preliminary and a final delivery. Of course, it is always possible to breakdown the “offending” element into as many WBS elements as milestones it maps to and associate each of them with the corresponding milestone, but this could be seen as something artificial that unnecessarily complicates the WBS just to satisfy the choice of notation.



The matrix “roof” defines the finish to finish dependencies between milestones. A dot at the intersection of two diagonals indicates that the milestone on the right cannot be completed until the milestone in the left has been completed. E.g. milestone β cannot be completed until milestone α has been completed

Milestone λ does not demand any effort from the project but must be completed before milestone ω can be completed. This type of milestone is used, for example, to model a delivery to the team, a synchronization point with other team, etc.

The “body of the house maps WBS elements to the milestones in the plan. WBS elements *s* and *w* contribute to the realization of milestone α or conversely, milestone α signals the completion of elements *s* and *w*. The total estimated effort to realize α is 450 hrs., 150 contributed by *s* and 300 by *w*

	α		β	β’	λ	ω	WBS elements’ effort
s	150						150
r			150	50			200
w	300						300
t						100	100
z							1,000
Work package effort	450		150	50		100	

The total effort required by WBS element *r* is 200 hrs. of which 150 are contributed to the realization of β and 50 towards β’

Level of effort WBS element *z* does not contribute directly to any milestone

Figure 4 The Milestone Planning Matrix

For the level of effort activities, we employ two tactics: When dealing with an activity such as integration in which the level of effort task could concurs to the realization of multiple milestones, we allocate a weighted fraction of its effort to each milestone to which it contributes. In the case of activities such as project management and quality assurance whose effort contributes to all milestones we do not allocate hours to any milestones and treat this effort as a work package that extends across the length of the project.

For outcomes that have a preliminary and a final delivery, e.g. the delivery of a draft document followed by a review and some later work to obtain final approval, and for which is important to highlight both events, we do one of two things: allocate a fraction of the WBS element’s budget to each milestone like we do for the level of effort tasks, or assign all the hours of the work package to the last milestone in a given milestone chain and discretionarily position the precursor milestone on the staffing curve.

Milestone scheduling canvas

Figure 5 below shows a typical milestone scheduling canvas. The canvas is a key piece of the process since it is there, that the plan materializes. Since the planning involves the physical positioning of sticky notes on the canvas, there has to be a correspondence between the work hours represented by each note and the canvas' physical dimensions. If for example, we choose a 3"x 3" sticky note to represent 40 hours of work, each three inches on the time axis of the canvas will correspond to a week and three inches in the resources axis will correspond to a full time equivalent (FTE) resource. Had we chose a lower granularity, e.g. a sticky note to represent 150 hours of work, which would be useful in the case of a larger project, each three inches on the time axis would correspond to a month instead of a week. One could rip off sticky notes to express fractions of effort or time but this should be hardly necessary given the resolution of the plan.

In constructing the staffing curve, we will assume the distribution of competences in the plan matches each work package needs. If one wanted to know or was somehow limited by the resource availability, it would be possible to break the work into competency lanes and assign the corresponding effort to each lane. The same approach could be applied when working with multiple teams.

The distribution of the sticky notes corresponding to a given work package on the scheduling canvas will delineate an imaginary time box for the associated milestone. Time boxes must exhibit the following properties: 1) they are totally located to the left of the corresponding milestone, 2) there are not overlapping sticky notes, 3) their time box contour reflects the nature of the work required, e.g. front loaded, back loaded, flat, early peaked, late peaked, etc. and 4) their height at any point does not surpass the amount of resources available that could reasonably be applied to the execution of the work package.

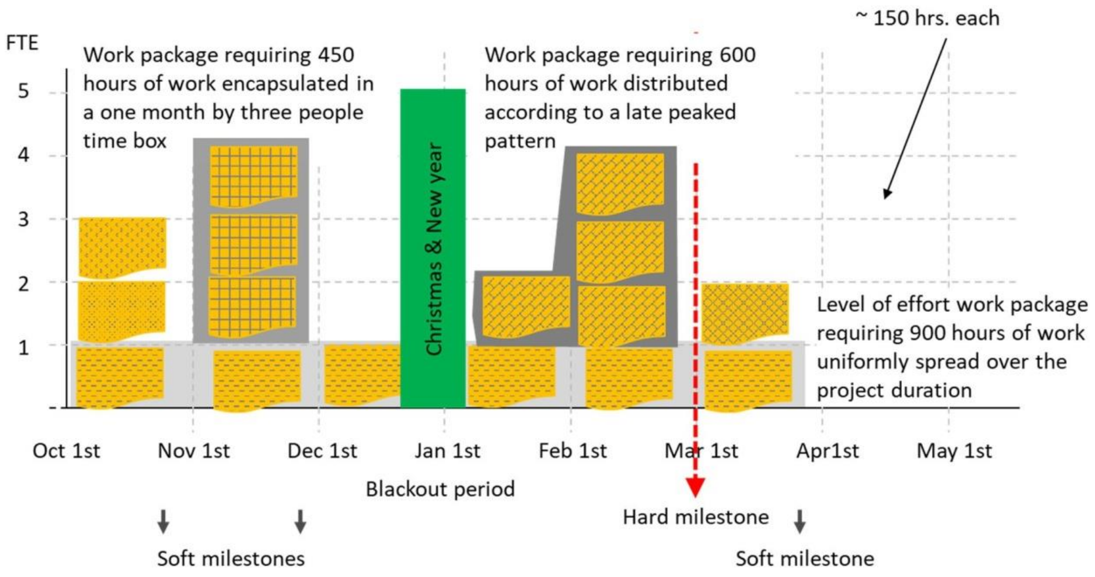


Figure 5 The Milestone Scheduling Canvas

After blacking-out any known non-working periods involving the whole team such as holidays, closings, and special vacation periods, the process of populating the milestone scheduling canvas will start by accommodating the work required by the level of effort activities such as project management and quality assurance that stretch over the length of the project or phase at defined manning levels. The next step would depend on whether or not the project contains hard milestones. If it does, we first post the work corresponding to them and after we move backwards to the start of the project (back casting) accommodating the work packages corresponding to the soft milestones in the order imposed by their dependencies. If there are no hard dates, the easiest way to proceed is to accommodate the work packages from left to right, starting at the beginning of the project and moving forward to the end along the most logical path. Sometimes the team might feel the need to introduce schedule buffers, which are not covered here for reason of space, to protect important milestones. Once all milestones have been layout, the due date for each milestone could be found by reading the corresponding dates in the horizontal axis of the scheduling canvas.

4 Detailed example

This section is organized around the method's steps shown in Figure 2 and serves two purposes: illustrate the application of the method, and validate it through its use in a made-up but not unreal project.

Imagine your company is bidding in a contract to develop an ecommerce site for a small book publisher and after some discussion with your customer you sketched the following notes:

a. The customer wants to include a beta testing period to validate the site design.

b. He will not accept deployment until a system wide acceptance test is satisfactorily completed.

c. Customer sign-off will follow satisfactory deployment of the system.

d. He would like to have at least three software releases: one to collect users' feedback via beta testing, another one to confirm the progress of the system towards the launch date and the final one to complete the system with minimum risk to the launch date.

e. In the first release he would like to include the following functionality: Category List (CL), Book Details (BD), Add to Cart (AC), Check-Out (CO) and all Data Base

f. In the second, the Category Book List (CBL), Remove from Cart (RC), Shipping Method (SM).

g. In the final release: Payment Details (PD), Process Payment (PP)

h. The customer is preparing to launch its business in April of next year so he would like the system to be ready at least one month before that.

For its part, your company:

i. Cannot start the project until the end of September and has only three developers and a project manager available to work on the project.

j. To minimize the risk of rework, it does not plan to start programming until the infrastructure is selected and the user interface and information architecture design are well underway.

Step 1

Based on the requirements above and its professional knowledge the development team created the WBS shown in Figure 6 describing their understanding of the contract's scope of work and estimated the effort required for its execution. The required software capabilities were grouped into four categories: Browsing, Buying, Paying and Data Base to increase the readability of the WBS as the team felt a grouping based on Releases would have difficulted the comprehension of system functionality. Website design, beta and acceptance testing could have been made part of the Website Software deliverable but the team chose to put them at the first level of the WBS to highlight its understanding of the customer wishes.

Step 2

After obtaining concurrence for the WBS from the client, the team started choosing relevant milestones and produced the list in Table 1. Beware that the solution is not unequivocal. While there are self-evident milestones like project kick-off, software releases and the client request for a beta test, others are created by the team based on its best judgment as to what is important and what is not. The completion criteria associated with each milestone defines its meaning and helps identify which WBS elements should be mapped onto them. The milestones are organized in what seems like the most logical sequence to make the list easier to understand and search for.

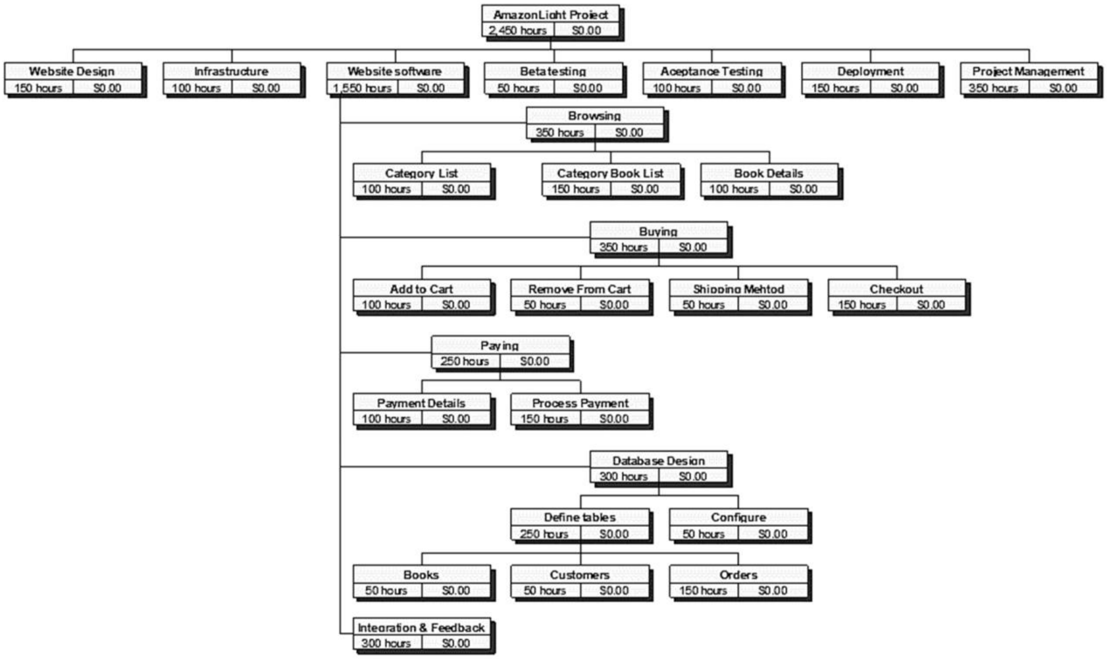


Figure 6 WBS fot the AmazonLight Project

Steps 3 &4

During step 3, the dependencies between milestones are defined and documented in the roof section of the milestone planning matrix and during step 4, the WBS elements are associated with their corresponding milestones. This is a pretty mechanical process whose value resides on the visibility it brings to the planning process. As discussed above, a WBS element can be associated with more than one milestone as shown by element 1.a in Figure 7. While this technique relieves us from creating WBS elements just for the sake of having each element map to a single milestone, abusing it obscures the mapping. Milestone "Cloud Infrastructure Available" has no WBS element associated with it, because although the work to select the infrastructure is part of the scope of the project, the effort to provision it, is not. The reason to include it as a milestone is that it represents a commitment made to the project team by the customer so they could beta test the system and to signal that a delay in fulfilling this promise could affect its completion date. Elements 1.c.5 and 1.g in in Figure 7 are level of effort tasks. In the case of "Integration & Feedback" a certain number of hours were allocated to each of the three milestones representing the completion of the software increment according to the amount of functionality to be integrated. In the case of project management, the effort was not allocated to any milestone to be later spread over the life-span of the project according to a uniform profile.

Step 5

This step corresponds to the drawing of the Milestone Sequence Chart and is not included here for reasons of space.

Step 6

By definition, a successful plan must satisfy its hard milestones. So in the case the project had contained such milestones, we would had started by marking them on the canvas as they would have constrained how the work packages' effort could have been distributed.

Steps 7, 8 & 9

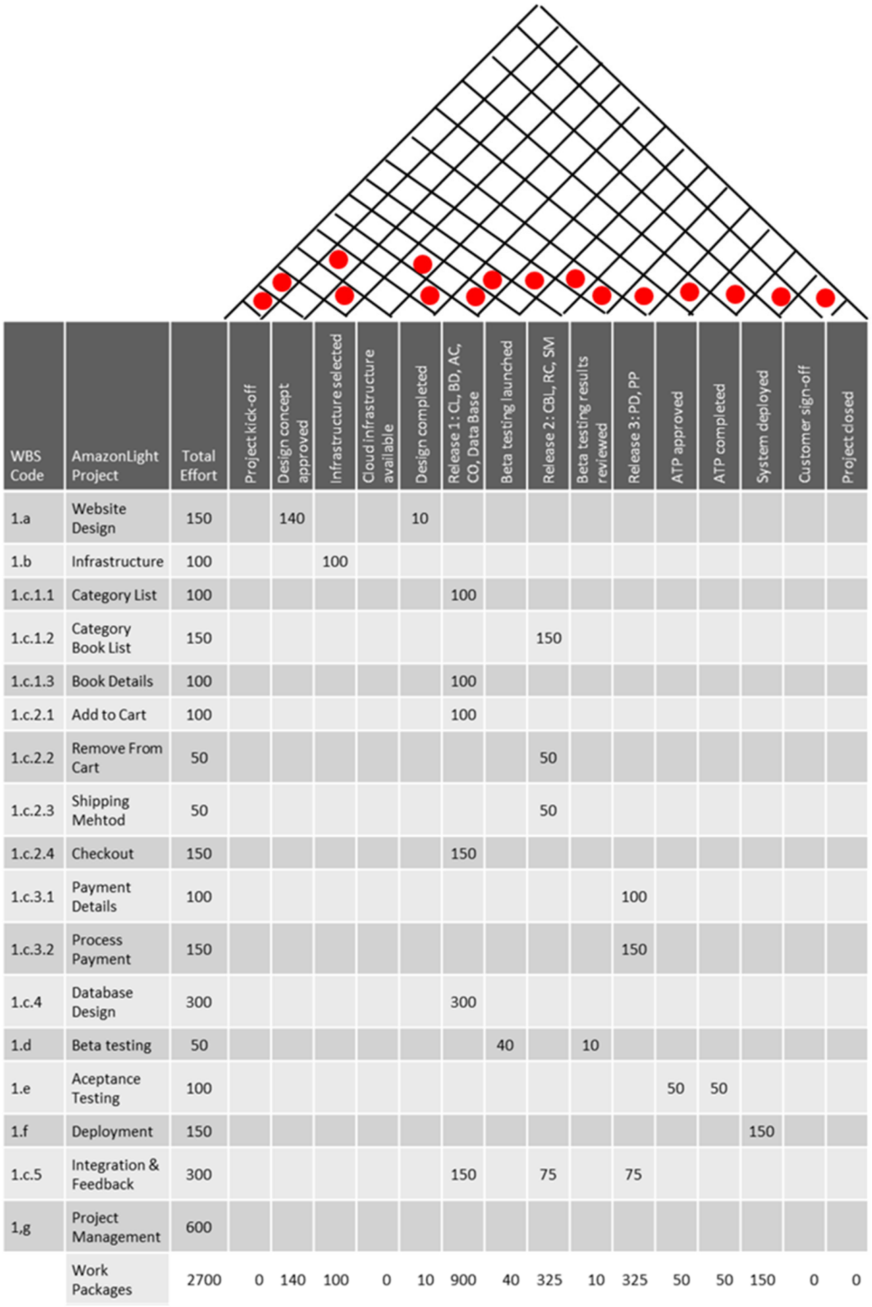
The goal of these steps is to establish a time frame in which the work represented by each work package could be executed. To do this, the team will label or somehow mark as many sticky notes as needed to cover the effort required by each work package and accommodate them in an appropriate empty space on the milestone scheduling canvass. The team starts by accommodating the effort corresponding to all cross-cutting work packages, then that corresponding to the work packages connected to hard milestones and finally that corresponding to the rest of the work packages in the order dictated by the milestones' dependencies. If necessary, the team might intersperse buffers to protect milestones deemed critical.

Figure 8 shows a possible plan for the AmazonLight project. Notice that due to the holiday period, extending from late December to early January the effort for the Release 1 work package was spread over two months by splitting the sticky notes. Another interesting case is beta testing, where the effort distribution for the work package follows a double hump pattern, some initial work for part of the team members at the beginning of the testing, followed by a lighter period while the users exercise the system, followed by an intense period to analyze the data and dispose of any findings.

As shown by the figure, with the constraints put on the available resources – three developers and a project manager – it is unlikely that the system could be deployed by early April as the customer wanted. At this point the team could ask for additional resources, reorganize the work, e.g. relax the condition of not doing development work before the design concept has been approved, negotiate the scope, change the completion deadline or just take its chances.

Table 1 Potential milestones for the AmazonLight project

Milestone	Rationale (from notes above)	Hard date	Completion criteria
Project kick-off	i	October this year	Development team assembled, meeting with project sponsor concluded
Design concept approved	j		Information architecture and UI designed and approved by sponsor
Infrastructure selected	j		Cloud provider selected. Consider AWS, Azure, Google Cloud and 2 others
Design completed	Proposed by team		Feedback from sponsor incorporated into design
Cloud infrastructure available	Proposed by team		Cloud production environment available
Release 1: CL, BD, AC, CO, Data Base	d		Indicated functionality is ready and tested at 90% coverage and working in production configuration. No broken menus or links
Beta testing launched	a		Release 1 software made available to beta users. User behavior hypotheses defined. Website instrumentation working
Release 2: CBL, RC, SM	e		Indicated functionality is ready and tested at 90% coverage and working in production configuration
Beta testing results reviewed	a		All insights arising from the beta testing disposed
Release 3: PD, PP	f		Indicated functionality is ready and tested at 90% coverage and working in production configuration. Changes resulting from beta testing implemented
Acceptance testing procedure approved	b		Acceptance test suite approved by sponsor. Includes at least one positive, one negative and one invalid test case for each functionality
Acceptance test completed	b		All acceptance test passed with no objection from sponsor
System deployed	c	May next year	All functionality running in production environment, operators trained. System must run for at least 15 consecutive days without a fault attributable to software
Customer sign-off	c		Customer accepts ownership of the software
Project closed			Project postmortem executed, all records archived



WBS Code	AmazonLight Project	Total Effort	Project kick-off	Design concept approved	Infrastructure selected	Cloud infrastructure available	Design completed	Release 1: CL, BD, AC, CO, Data Base	Beta testing launched	Release 2: CBL, RC, SM	Beta testing results reviewed	Release 3: PD, PP	ATP approved	ATP completed	System deployed	Customer sign-off	Project closed
1.a	Website Design	150		140			10										
1.b	Infrastructure	100			100												
1.c.1.1	Category List	100						100									
1.c.1.2	Category Book List	150								150							
1.c.1.3	Book Details	100						100									
1.c.2.1	Add to Cart	100						100									
1.c.2.2	Remove From Cart	50								50							
1.c.2.3	Shipping Mehtod	50								50							
1.c.2.4	Checkout	150						150									
1.c.3.1	Payment Details	100										100					
1.c.3.2	Process Payment	150										150					
1.c.4	Database Design	300						300									
1.d	Beta testing	50							40		10						
1.e	Aceptance Testing	100											50	50			
1.f	Deployment	150													150		
1.c.5	Integration & Feedback	300						150		75		75					
1,g	Project Management	600															
	Work Packages	2700	0	140	100	0	10	900	40	325	10	325	50	50	150	0	0

Figure 7 Milestone planning matrix for the AmazonLight project

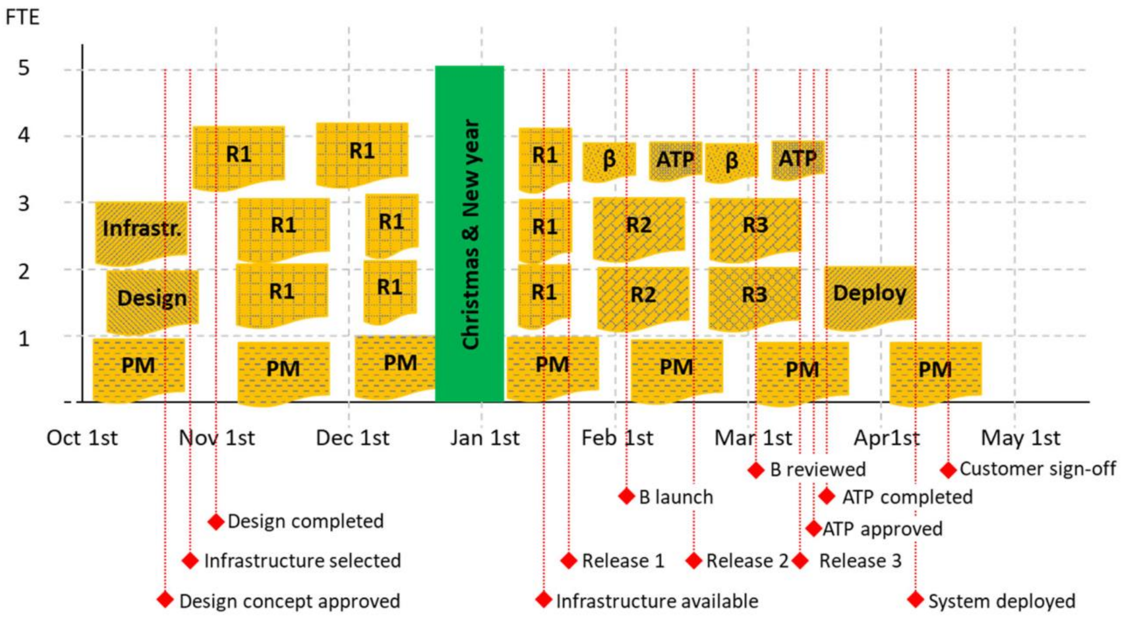


Figure 8 Staffing curve showing the chosen milestones for the AmazonLight project

Step 10

In Step 10, the milestone plan is completed by reading from the milestone scheduling canvas the approximated date in which the work associated with each milestone will be completed and assigning it as the due date for the milestone.

5 From milestones to tasks

A milestone plan is not directly “executable’ as it does not prescribe the tasks to be carried out. Its purpose is to serve as basis for making rational commitments, provide an organizing principle for the project and goalposts for synchronization across the many actors that could be involved in the project. To make the plan executable, the project team will progressively refine each milestone’s work package content into the tasks necessary to complete it within the time and resource frames established by the work package’s time box. As work progresses, the milestone plan could be updated to reflect new circumstances arising from the work completed or from changes in the project context, but since milestones are basically states or goals to be attained, the plan tends to be pretty robust.

Depending on the project context, e.g. traditional, hybrid or agile these planning sessions take different names, e.g. planning waves (Githens, 2007) (Project Management Institute, 2017), iteration planning meetings (Wells, 2019), sprint planning meetings (Rubin, 2013) and look ahead planning (LCI - Israel Chapter, 2019) among others.

Typically, these sessions will include a review of the current state and vision, a determination of the team capacity over the planning horizon considered, a selection of the work to be tackled as informed by the milestone plan, a decomposition of this work into tasks and if necessary, an instruction to update the milestone plan. The planning session might include a task allocation step depending on whether the team follows a push or pull model for task assignment.

In a rolling wave planning context, the planning sessions could be made to coincide with the achievement of a relevant milestone or at discretionary times over the life of the project, see

Figure 9, but in a Scrum context they are scheduled at regular intervals, see Figure 10, coincident with the length of iteration chosen.

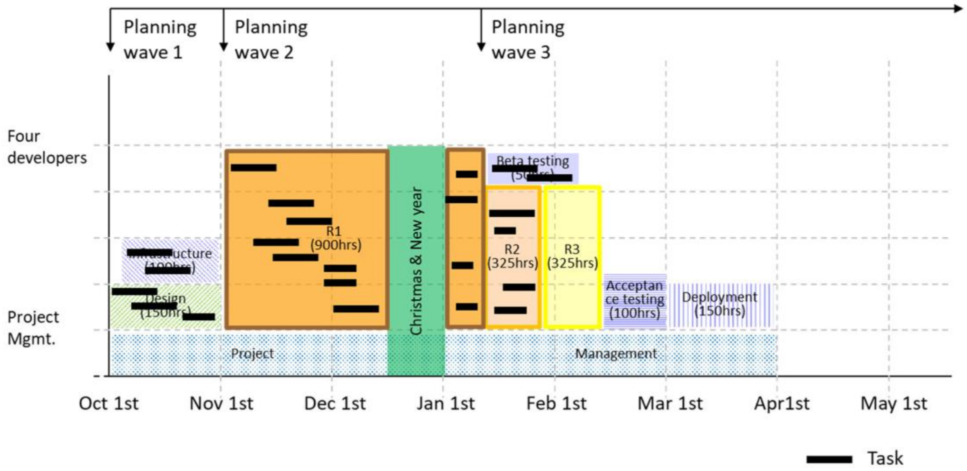


Figure 9 The rolling wave planning approach

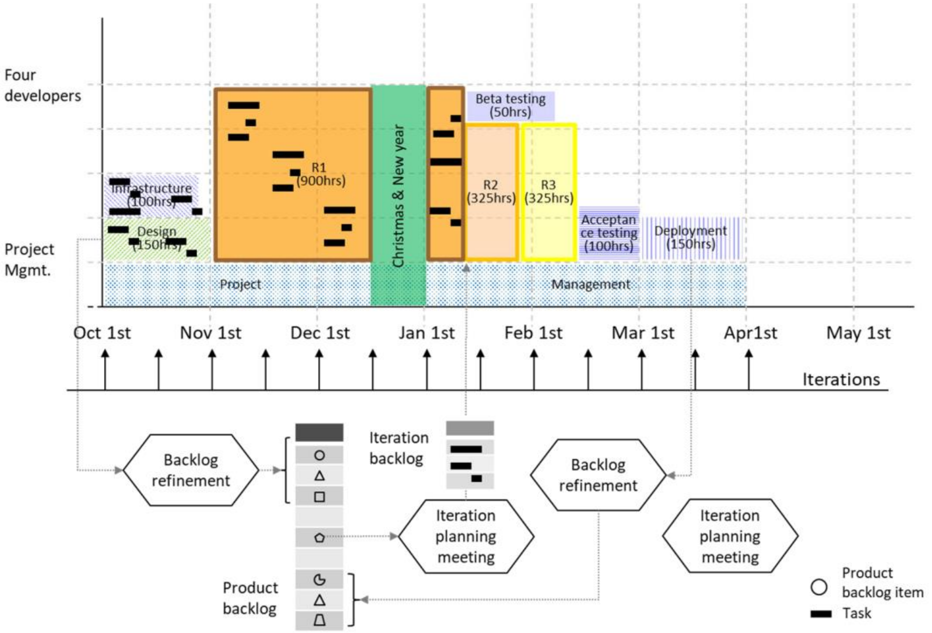


Figure 10 The iteration planning approach

6 Initial evaluation

An initial evaluation of the method, from the process perspective, was performed through an independent assessment of its usability (Fontdevila, Genero, & Oliveros, 2017) and by surveying a small number of graduate students using the method in their capstone projects. The first evaluation aimed to assess the method's learnability, understandability, visibility, adaptability, controllability and attractiveness through its description and the second, the claims of comprehensiveness, understandability and acceptability, through the actual experience of using it. Tables 2 and 3 respectively summarize the results of the evaluations. Although a single assessment and the results of a small survey, 10 students were asked to complete the survey but only 6 responded, in an academic environment might raise concerns with regards to the generalization of any conclusion, both attest to the merits of the method in terms of its ease of use and the promotion of collaboration and buy-in.

Table 2 VMP Usability Evaluation

Characteristic measured	Metric	Definition	Assessed value (Possible values)	Comment
Self-evident purpose	Appropriateness of name	Measures how appropriate the name is for describing the purpose of the process or practice.	Appropriate (Deceiving, Ambiguous, Partial, Appropriate, Accurate)	The name describes the essential aspects of the method, that is is visual (and reified) and that it is milestone based and that its purpose is planning
	Purpose alignment for stakeholders	Measures the alignment of purpose for all stakeholders.	Complete (None, Low, Medium, High, Complete)	The method is a team level planning method, and uses visibility to enhance "shared understanding by stakeholders"
Learnability	Volume of information of introductory material	Measures the size of introductory material as defined by authoritative sources, e.g. for an authoritative introductory course.	6500 (Number of words)	The word count for "Milestone Planning: A Participatory and Visual Approach"
	Standard introductory course duration	Measures standard course duration in hours, as defined by authoritative sources.	8hs (Number of hours)	Informed by the author [Miranda]
Understandability	# of elements	Measures how many components make up the definition of the process or practice.	15 (Number of elements)	Outcomes, Milestones, Dependencies, Milestone Planning Matrix, MIlestone Sequence Diagram, Milestone Effort, Cross- cutting Effort, Milestone Dates, Soft Milestone, Hard Milestone, WBS. Milestone work package, Effort unit of time, Milestone scheduling canvas, Milestone list

	Conceptual model correspondence	Measures the level of correspondence between the user’s conceptual model of an activity and the conceptual model of that same activity that the process or practice implies.	High (Low, Medium, High)	It is a participatory planning activity, were the team is responsible for carrying out the plan. The meaning of milestones and due dates is fairly straight forward, aa is the rest of the conceptual model.
	Data model complexity index	Measures the subjective complexity of the data model.	Medium (Low, Medium, High)	In general the data model has low complexity, but specific elements like the pair-wise dependency matrix "roof", the existence of two types of milestones and two types of effort makes the overall data model less simple.
Error tolerance	Cost of error	Measures the cost of error as overall impact.	Low (Low, Medium, High)	The focus on milestone planning makes plans "much more stable and practical" than task or activity oriented plans [Miranda]. The cost of modifying milestones is lower than that of modifying tasks. Making the plan and its elements visual also make it easier to detect issues and gauge the impact of modifications.
	Safety perception	Measures how safe is it to use the process or practice.	High (Low, Medium, High)	The team participates in planning its own work. That provides a safer environment for establishing commitments since they are not imposed from the outside. Depending on the culture of the organization around the team, and the level of autonomy that the team has in planning and executing the plan, the cost of error may vary.
	Use of restraining functions	Measures whether the process or practice provides hard restrictions to prevent risk materialization.	Yes (Yes, No)	The scheduling canvas scale to the sticky notes size offers visible hard restrictions on milestone planning to avoid resource over allocation and help validate milestone viability

Visibility	# of indicators	# of indicators	N/A (# of indicators)	Progress is reflected in the degree of completion of the items being produced. No additional indicators
	Use of information radiators	Use of information radiators	Yes (Yes, No)	Scheduling canvas, Milestone Planning Matrix
	Audience alignment for information	Audience alignment for information	Yes (Yes, No)	There is no specific mention of information tailoring
Controllability	Degree of control concentration by role	Degree of control concentration by role	N/A	The method does not define roles nor state how are made decisions among different stakeholders
	Level of autonomy	Level of autonomy	Medium (Low, Medium, High)	Teams have a say and are involved, not necessarily self-organized
	Control granularity	Control granularity	Fine (Fine, Medium, Coarse)	WBS items and work packages can be arbitrarily decomposed
Adaptability	# of adaptation points	# of adaptation points	1 (# of points)	Milestone sequence diagram is optional
	Ratio of roles allowed to adapt	Ratio of roles allowed to adapt	N/A (0 to 1)	No roles defined
Attractiveness	User attractiveness rating	User attractiveness rating	4 (1 to 5)	Assessor opinion after reading the paper
User satisfaction	User experience rating	User experience rating	No rated (1 to 5)	The author reports anecdotal "positive initial responses encountered" in both classroom and industry settings. A more precise measurement of satisfaction might provide interesting insights

Table 3 VMP Comprehensiveness, understandability and acceptability survey results

	Totally disagree	Somehow disagree	Somehow agree	Totally agree	Comments
The method allowed you to have a say in the planning process			1/6	5/6	
After finishing the plan, you felt you understood why it was constructed the way it was, even if you might not totally agree with it			3/6	3/6	
You would feel comfortable explaining the plan to others outside the planning team			3/6	3/6	
The visual nature of the method helped the team find elements it might have overlooked		1/6	2/6	3/6	
The visual nature of the method helped you communicate your ideas to other members of the planning team			3/6	3/6	
The visual nature of the method prevented you from making mistakes			4/6	1/6	One response had to be eliminated because the student marked all columns
You liked the method before you started planning		1/6	3/6	2/6	
Overall it was a pleasant experience			2/6	4/6	

7 Summary

Any project of any size or consequence needs an organizing principle that is understood and shared by all members of the project team. Without it, project members struggle to know what to do next and stakeholders with what to expect and when. While it has long been established that a milestone plan can effectively fulfills this guiding role, its collaborative construction as proposed here reinforces the well-known benefits of team members' engagement, buy-in and ownership. The VMP method has evolved over three years of classroom and consulting experience and has been put into practice in mid-sized capstone projects, 2,500 to 5,000 person-hours long, and at two industrial organizations. Although further experience and assessments are required, its initial evaluation and observations point in the direction of the method's ease of use and its value in organizing a project.