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From Estimate to Project Plan

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SCOPE OF THIS ARTICLE

There is a great deal of information available about how to estimate a project. Among other sources, the International Function Point User's Group, and Q/P Management Group provide information and classes on the subject. There is also a wealth of information about how to create a project plan. The Project Management Institute is one of many sources for more of this information. Although this article will necessarily probe into both of those areas, the overall purpose is to provide an overview to detail the *transition* from the project estimate to the operational project plan.

There are many considerations and potential pitfalls along the way. There are as many ways of estimating and creating a plan as there are practitioners. Many are good, but some are better than others for various situations. The trick is to choose wisely.

ESTIMATION PROCESS FOR PROJECTS

An estimate is defined as the approximation of the effort, cost, schedule and/or quality of a project. It is a prediction, or forecast, in quantifiable terms. Estimates are often required in order to clarify and/or quantify commitments and agreements, monitor progress of a project, provide the ability to recognize and correct project problems, and improve communication between parties.

Estimation is useful for software development and implementation projects as well as for software maintenance efforts. Since the focus of this article is the development of project plans from estimates, concentration will be on the former.

The Process

The creation of an estimate is a process, since it is both more complex and more time consuming than simply placing numbers on a sheet of paper. The process involves the proper derivation of appropriate figures as well as the ongoing maintenance of the estimate once it's established. Maintenance, in this case, means monitoring project progress against the estimate, and updating the estimate as necessary.

For a given organization, the estimation process will improve over time. This is partly due to the time required for building and using a history of project estimates and partly due to the increased experience that comes with using the process. The use of a project history database can be a tremendous help in the creation of an estimate. Project history data can and should be gathered within an organization, but can also be obtained industry-wide from various sources. There is also no substitute for experience. Those involved with the process learn more about what is expected, how best to document and communicate assumptions, and how best to use ranges in their estimates over time.

What is Being Estimated

Size is the most important factor in the estimation process. Size is best estimated in function points, although other metrics can be used. The more the estimating team knows about the number of files, screens, reports, etc., the better the overall estimate will be. Depending on the knowledge early in the process, a Rough Order of Magnitude, or ROM Function Point Count, can be extremely useful. A more detailed function point count can be conducted later in the process, once more information is available.

Effort hours (or months, etc.) are calculated based on size, methodology, tools and technology, resources,

and project historical data. Effort can be broken down by activity and/or resource.

Cost is based on effort, size, or some combination. Other project costs, such as equipment and software, must be included as well. Cost may also be broken down by activity.

Time, or duration, is a function of effort and available resources. The project schedule is the most accurate manifestation of the duration, but it is usually considered part of the project plan, but an initial, high level schedule may be included as part of the estimating process.

Quality, in terms of number of defects, or number of defects over time, is estimated based on size, time, and project historical data.

Of the factors above, cost and duration are often the most important to the project sponsor. The questions, "When can I have it?" and "How much will it cost?" are the ones heard most often with regards to a project estimate.

Types and Methods of Estimates

At the highest level, there are two types of estimates: bottom-up and top-down. Bottom-up estimating entails breaking down all of the tasks or activities, and creating an estimate for each one. All of the activity estimates are then added together to form a project estimate. Top-down estimating relies more on metrics and project historical data. Top-down estimating results in the project estimate first, but it may later be broken down by task or activity based on methodological formulas.

Which works better? Top-down estimating can often be faster, but may not provide as much detail. Bottom-up estimating can provide more detail, and can better ensure that nothing is overlooked, but usually takes longer. Both methods can be accurate if done correctly. If possible, the best solution is to employ both methods, and then compare the results. The reconciliation will yield important information, and make the resulting estimate as accurate as possible.

Within these two types, there are many subtypes and additional methods. Some are performed at the task or activity level, while others are also at the project estimate level. Waterfall, iterative and spiral patterns all have unique advantages and disadvantages, but the goal for all of them is to improve the overall estimate through the use of a defined process. They are often used at the project level.

The Optimistic, Likely, Pessimistic (OLP) technique uses balance weighting to derive an estimate, usually at the task or activity level. Also at the task or activity level, the Delphi technique involves having several knowledge experts secretly derive an estimate, and then reconcile the differences as a group.

Recommendations

Estimates should be given in ranges. Upper and lower tolerances are defined. Ranges highlight the uncertainty of the process – especially early on. They also avoid the "number stuck in the head" (by the customer, project sponsor, and others) syndrome. As the estimation process proceeds the ranges can be narrowed or eliminated.

All assumptions should be stated. The estimator, the project manager, the project sponsor and the project team may all be working under different sets of assumptions. This can have disastrous effects. By placing all assumptions in writing, the estimator takes a huge step towards making the estimate and the entire project successful.

Strict attention should be paid to the constraints on the project as well as the constraints on the estimate itself. These are two different things. The project constraints limit time, resources, costs or other factors for the development of the project. Constraints on the estimate dictate the amount of time, resources or costs are to be spent on developing the estimate itself. A third type of constraint, constraints on the product, is to be taken into account during the design phase of the project.

It is absolutely necessary to get "buy-in" from the people who will actually do the work. The more input they have into the estimating process, the better the result, and the more likely the success of the project once it's begun. If this is not done, team members will feel that the estimate is "imposed" on them and problems will arise. Of course it's also necessary that the project sponsor also agrees that

the estimate is realistic, and for the work that is truly required.

Using the Estimate to Create a Project Plan

What is a project plan, anyway?

The project schedule is often called a "project plan". It isn't. It is, however, a major component of a project plan. A project plan is a document, a directory, or simply a group of documents that lay out the plans for a project to be developed. The components may differ by organization, but the ones most often included are:

- Project Scope Statement – a narrative to describe the overall scope of the project
- Work Breakdown Structure, or WBS – the logical breakdown of the work to be performed
- Schedule – the layout of the durations by WBS tasks or activities
- Resource Plan – the plan for acquiring and assigning resources
- Risk Plan – includes the risk identification and assessment – their potential impact on the project
- Quality Plan – the plans to prevent, identify, categorize and solve defects
- Budget and Procurement Plan – the spending plan
- Communication Plan – a plan to communicate project progress to project stakeholders

Project Attributes

Project attributes are factors about the development environment that may affect the project. They include personnel and management questions on experience at various disciplines, the organizational structure, the corporate or organization culture, and management support for the team. Process and methods questions are about the systems development methodology, project management, requirements definition, quality assurance and control, and measurement. Technology and tools questions include those relating to computer resources, CASE tools, construction tools, and testing and debugging aids. Finally, environment and support characteristics are about office space, meeting room facilities, supplies, administrative support, and communications.

Project attributes have a major impact on the project plan. Depending on weighting factors employed, each category noted above may be used to adjust the estimate by as much as 25 to 100 percent.

Project Planning Process

Once the estimation process has progressed to a point where numbers are available for effort, cost and quality, they can be incorporated into a project plan. Project planning, however, can even begin before these are available; some of the sub-processes do not depend directly on estimation information.

Project planning is broken up into sub-processes known as Core and Facilitating Processes. The Core Processes consist of Scope Planning and Definition, Resource Planning, Schedule Development, and Cost Budgeting. The Facilitating Processes are Quality Planning, Organizational Planning and Staffing, Communication Planning, Risk Planning, and Procurement Planning.

The primary project planning sub-process is Scope Planning. The purpose of scope planning is to create a Project Scope Statement. Scope planning leads to Scope Definition. Scope Definition involves subdividing the major deliverables into manageable packages.

The purpose of resource planning is to create a Resource Plan. The resource plan will, in turn, be used for staffing, schedule planning and cost planning.

Since the schedule is certainly one of the most important and visible components of the project plan, Schedule Planning is an important and highly visible process. The scope definition defined work packages are further refined into activities, which are then sequenced in the form of a Work Breakdown Structure. The WBS, along with corresponding effort estimate information, is used to schedule the work. The resource plan is another major input. The resulting Project Schedule can be further refined as more is known about estimates, resources and tasks.

There are many tools available to assist with Schedule Planning.

Cost Budgeting involves taking cost estimates, and other information and creating a Project Budget.

Among the Facilitating Processes, the Quality Planning sub-process uses defect information from the estimate to create a Quality Plan.

Organizational Planning and Staffing is the sub-process where the organization for the project team is defined and/or refined, and the Staffing Plan is derived, based on the Resource Plan.

Communication Planning is concerned with determining which stakeholders need what information, and how to provide that information. A Communication Plan is produced as a result.

The purpose of Risk Planning is to identify, quantify and define responses for all known project risks. Additional risks may be added to the resulting Risk Plan as they are identified.

Procurement Planning is used to determine what to procure and when, based on the cost estimate and other information. A Procurement Plan is created as a result. A solicitation plan may be produced as well.

For more information about the project planning process, refer to the Project Management Institute's *Guide to the Project Management Body of Knowledge*.

Execution of the Project Plan

Once the plan has been accepted, it's time to complete (mostly) the planning of the work, and to begin working the plan. This is at least as important a subject as the creation of the project plan, but it is beyond the scope of this article.

Other Project Planning Notes

Project planning is not a sequential effort. Many of the sub-processes are interdependent, so the entire effort is an iterative one. In the same way, the transition from estimate to project plan is not necessarily sequential. Some project planning can certainly be initiated as soon as the estimating process has begun. Of course, certain project plan components depend on inputs from the project estimate, but this effort is iterative as well.

Example

The best way to illustrate the process of creating a project plan from an estimate is by example. The data employed is entirely made up for this paper; none is based on any actual project data. Therefore, the costs, schedules, etc. as estimated, may or may not bear any resemblance to any real projects. The example will still be instructive, however, regardless of the source of the data used.

This example will make use of an all-purpose metrics estimating project planning tool, PQM Plus. Other all-around tools, such as QSM SLIM-Estimate could have been used as well. The illustration is of the early stages of estimating and related project planning. The remaining work related to the project plan creation is not trivial; in fact, it's quite extensive. But it's also beyond the scope of this example.

The first step is to initiate both the project and the application boundary within PQM Plus. The methodology to be used is chosen as part of this process. The development methodology used for this example is PQMP*Lus* IEM. Note that several options are available and other methodologies can also be imported into the user's PQMP*Lus* Database. Once this is complete, we can proceed to the next step.

Rough Order of Magnitude

We begin the estimating process with a ROM estimate. Remember that application size is the most important factor to consider. Size is best measured in terms of function points. Rough Order of Magnitude calculations are intended for the earliest stages of the estimating process, especially when more specific information is not available. PQM Plus makes use of various ROM models in order to project counts of, say, External Inputs, External Outputs and External Inquiries based on a given number of Internal Logical Files. Once the number of Internal Logical Files is entered, and the quantities of other functions created, any of the numbers can be adjusted at will. For each type of function, a mean complexity figure is also projected, based on the ROM Profile. As with the quantities of functions, the complexity can be adjusted as required. For the ROM estimate, the Value Adjustment Factor can also be estimated without detailed analysis.

For this example, 18 was entered for the number of Internal Logical Files, 5 was entered for the number of External Interface Files, and then slight adjustments were made to the other projected quantities. We'll assume that all functionality is new (nothing changed or deleted), and that there will be no data conversion activity. The mean complexity of functions for this ROM Profile tended to be mid-range for each type of function. The values were left unchanged for this example. We'll also assume that the Value Adjustment Factor will stay at the default value of 1.00. Note that for many modern applications with heavy online activity, the Value Adjustment Factor may be higher. The result shows an estimate of 999 adjusted function points.

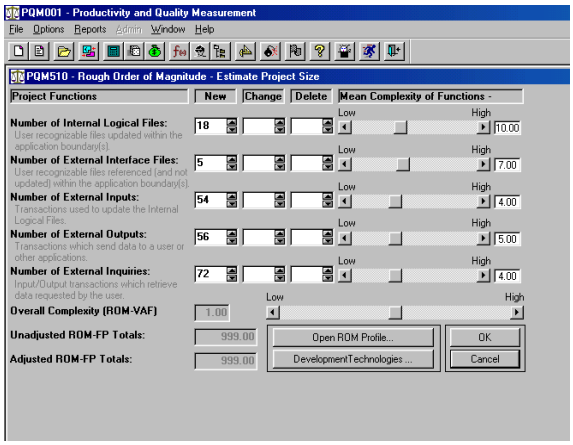

Figure 1: ROM Estimate

At this point, the development technologies to be used may be entered as part of the ROM estimating process. Figure 2 illustrates some technologies entered for this example.

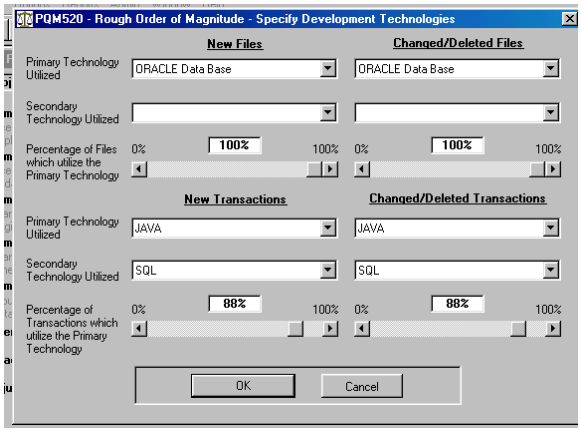

Figure 2: ROM Development Technologies

Risk Analysis

Every project estimate should take the project risk into account. The PQM Plus tool enables the user to assess the project risk by use of a questionnaire. A number of risk attributes are presented by category. Each attribute is scored by the user with a value from 0 through 10. Higher scores indicate higher risk. Figures 3 and 4 illustrate the Risk Assessment process used by PQM Plus. The risk attributes have been scored with some numbers for the example.

Once the user completes the risk analysis, a Risk Adjustment Factor is calculated to represent overall risk. A factor of 1.00 would represent average risk; one that is above or below 1.00 would represent higher or lower overall risk, respectively. For this example, the calculation comes up with a Factor of 1.16.

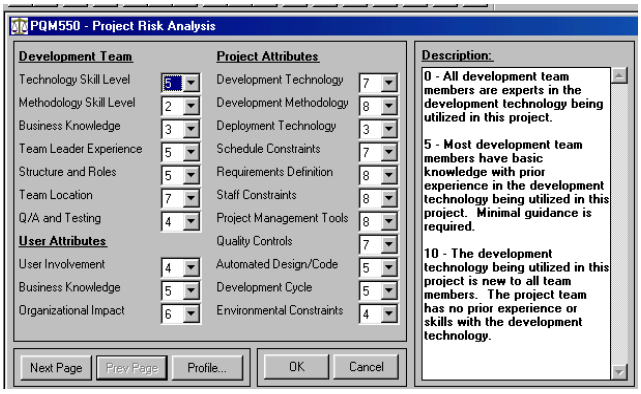

Figure 3: Risk Analysis Screen 1

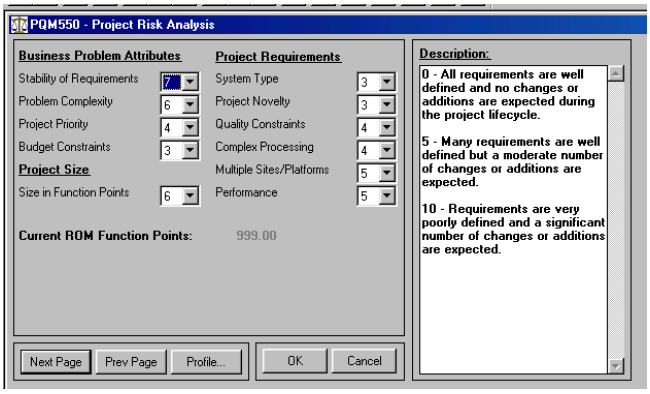

Figure 4: Risk Analysis Screen 2

Project Workplan

Once the ROM information is entered, and the Risk Assessment is complete, the initial Project Workplan can be generated. The user specifies that the Rough Order of Magnitude is to be used to generate all of the chosen methodology tasks for the workplan. For this example, we'll use industry benchmark data. Remember that the development methodology has already been chosen for this project. At future points in the estimating process, a detailed project function point count will be available, and then chosen in place of the ROM count as the input source.

Figure 5 on page 7 shows the Estimate Report that results from the generation of the Project Workplan. There are several considerations with regard to the report:

- The Risk Adjustment Factor of 1.16 is used to modify the Standard Estimate hours for each generated task, and thus the Total Hours.
- The Unadjusted and Adjusted Function Point counts of 999.00 are equal since we chose to keep the Function Point Value Adjustment Factor at 1.00.
- The Total Hours is based on the sum of the hours for all of the tasks.
- For this example, a cost per function point of $1000.00 is used for both the Standard and Risk Adjusted Estimates. This brings the Total Cost for the project to $999,000.00. This makes the cost per person-hour $70.03 for the Standard Estimate and $60.37 for the Risk Adjusted Estimate. The estimator may want to perform a sanity check at this point to determine if these rates are in line with what is expected and typical.
- The report shows that the number of Function Points developed per hour is 0.0700 for the Standard Estimate and 0.0604 for the Risk Adjusted Estimate. It may be time for yet another sanity check.
- The hours are distributed by task according to the PQM Plus profile for this methodology. The factors can be adjusted as required.

At this point, the early stages of the estimate to project plan process are complete. The Project Workplan can now be exported to Microsoft Project format or other formats. Once the estimator/project planner has imported the tasks and their respective effort hours, resources can be assigned and a schedule can be generated. As noted at the beginning of the example, the effort involved in these latter project planning stages is quite extensive. Some products, such as SLIM-Estimate and Bridge Modeler can make this portion of the process more efficient and effective.

About the author

Daniel Horvath, Senior Management Consultant, Q/P Management Group wrote this article. Mr. Horvath specializes in project management and software engineering metrics, including function point analysis.

PQM P*lus* Estimate Report - Technology ROM FP

Project ID	Test3	**Project Name**	Test Project 3
Project Manager	SYSTEM ADMINISTRATOR	**Methodology**	PQMPlus SDM
Project Owner	QPMG	**Start Date**	Jan 21, 2002
Risk Value	53.07	**Risk Adjustment Factor**	1.16
Unadjusted Function Points	999	**Adjusted Function Points**	999.00

	Total Hours	Total Cost	Cost per FP	FP per Hour	Schedule Days	FTE Staff
Standard Estimate	14,265.00	$999,000.00	$1,000.00	0.0700	N/A	N/A
Risk Adjusted Estimate	16,547.40	$999,000.00	$1,000.00	0.0604		

Task ID	Description	Std Estimate	Risk Estimate
PHASE001	PROJECT INITIATION/FEASIBILITY STUDY	0.00	0.00
P1100	Manage & Coordinate Project Activities	49.95	57.94
P1200	Define & Document Business Objectives/Processes	299.70	347.65
P1280	Create a New Project Definition (PQMPlus)	9.99	11.59
P1300	Perform Initial ROM FP Estimate (PQMPlus)	39.96	46.35
P1400	Perform Initial Corp. Value Analysis (PQM Plus)	29.97	34.77
P1500	Perform Initial Risk Analysis (PQMPlus)	29.97	34.77
P1600	Create High Level Project Workplan (PQM Plus)	39.96	46.35
P1700	Complete Project Plan Documentation	99.90	115.88
P1800	Review and Obtain Approval of Project Plan	99.90	115.88
P1900	PROJECT INITIATION/FEASIBILITY STUDY Complete	0.00	0.00
PHASE002	FUNCTIONAL & TECHNICAL DESIGN	0.00	0.00
FTD100	Manage & C00rdinate Project Activities	149.85	173.83
FTD200	Conduct Project Team Training	0.00	0.00
FTD300	Define/Document Business Processes/Transactions	709.29	822.78
FTD400	Define/Document Data Requirements (logical D/D)	339.66	394.01
FTD500	Define and Document Technical Architecture	209.79	243.36
FTD600	Develop Detailed Cost/Benefit Analysis	99.90	115.88
FTD700	Perform Detailed FP Analysis (PQMPlus)	49.95	57.94
FTD800	Review/Update Project Risk Analysis (PQM Plus)	9.99	11.59
FTD900	Review/Update Corporate Value Analysis (PQMPlus)	9.99	11.59
FTD1000	Create Detailed Project Workplan (PQMPlus)	19.98	23.18
FTD1100	Complete Project Plan Documentation	199.80	231.77
FTD1200	Review and Obtain Approval of Project Plan	99.90	115.88
FTD1300	FUNCTIONAL & TECHNICAL DESIGN Complete	0.00	0.00
PHASE003	DEVELOPMENT & TESTING	0.00	0.00
DTI00	Manage & C00rdinate Project Activities	319.68	370.83
DT200	Design & Develop Test Plans	299.70	347.65
DT300	Order/Procure Operating Equipment	0.00	0.00
DT400	Develop Test Environment	0.00	0.00
DT500	Develop Operating Procedures	209.79	243.36
DT600	Develop Disaster/Contingency Plan/Procedures	199.80	231.77
DT700	Develop User/Customer Manuals/Help Text	509.49	591.01
DT800	Develop Implementation Strategy/Plan	189.81	220.18
DT900	Review/Update Project Risk Analysis (PQMPlus)	9.99	11.59
DT1000	Review/Update Corporate Value Analysis (PQMPlus)	9.99	11.59
DT1100	Review/Update Detailed FP Analysis (PQMPlus)	19.98	23.18
DT1150	Conduct Integration Tests/Log Defects	429.57	498.30
DT1200	Conduct User/Acceptance Tests/Log Defects	309.69	359.24
DT1300	Resolve/Repair Defects	509.49	591.01
DT1400	Conduct Stress/Performance Tests	209.79	243.36
DT1S00	Complete Project Plan Documentation	219.78	254.94
DT1600	Review and Obtain Approval of Project Plan	99.90	115.88
DT1700	DEVELOPMENT & TESTING Phase Complete	0.00	0.00
PHASE004	PROJECT IMPLEMENTATION & EVALUATION	0.00	0.00
PIE100	Manage & C00rdinate Project Activities	99.90	115.88
PIE200	Install & Test Operating Equipment	0.00	0.00
PIE300	Conduct User/Customer Training	199.80	231.77
PIE350	Conduct Beta/Parallel Tests/Log Defects	299.70	347.65
PIE400	Implement Project	199.80	231.77
PIE500	Resolve Defects/Discrepancies	149.85	173.83
PIE600	Transition Project to Support Team	159.84	185.41
PIE700	Review/Update Project Risk Analysis (PQMPlus)	9.99	11.59
PIE800	Review/Update Corporate Value Analysis (PQMPlus)	9.99	11.59
PIE900	Conduct Technical Quality Survey (PQMPlus)	109.89	127.47
PIE1000	Conduct Functional Quality Survey (PQMPlus)	149.85	173.83
PIE1100	Complete Project Completion Report	209.79	243.36
PIE1200	Review/Obtain Approval of Project Completion Rpt	99.90	115.88
PIE1300	PROJECT Complete	0.00	0.00
CSTRUCT1	Construct New Application Functions	6,423.00	7450.68
CSTRUCT2	Update Changed Application Functions	0.00	0.00
CSTRUCT3	Remove Deleted Application Functions	0.00	0.00
CSTRUCT4	Construct Conversion Functions	0.00	0.00

Figure 5: Project Workplan Report