Software Estimating on a Shoe String

ASQ – SSQ Meeting, September 25th, 2007

Presented by:
William D. Hart, PMP
Soft Solutions Consulting, Inc.

Agenda

- Discuss how our estimating of software development projects evolved from tools and procedures that we developed in 2000 to those that we use today.
  1. Initial Tool
  2. Enhanced Tool
  3. Function Point Based Estimate Tool

In the Beginning – Our Procedure

- Estimating procedure defined specific inputs and outputs using Rob Thomson's [1] approach for 3rd wave project management.
- Inputs/outputs are derived from Software Change Request (SCR).
- Procedure decomposes the SCR into business requirements and then into a lower level of abstraction.
  - Level of abstraction we used was a user defined feature point.
  - Procedure defines feature point.

In the Beginning – Types of Feature Points

- Screens and Output Files
  - # of simple user interface screens
  - # of moderately complex user interface screens
  - # of complex user interface screens
  - # of simple output files
  - # of moderately complex output files
  - # of complex output files

In the Beginning – Types of Feature Points

- Business Logic and Interfaces
  - Amount of simple business logic required to support the screen displays
  - Amount of moderately complex business logic required to support the screen displays
  - Amount of complex business logic required to support the screen displays
  - Amount of simple business logic to support the process
  - Amount of moderately complex business logic to support the process
  - Amount of complex business logic to support the process
  - Interfaces to other systems not under our control (list all that apply)

In the Beginning – Estimating Spreadsheet

<Project X>							
Function Point Type	**Number**	**Optimistic**	**Realistic**	**Pessimistic**	**Expected**	**Rate**	**Cost**
Screens							
The number of simple user interface screens					0.00	$80	$0
The number of moderately complex user interface screens					0.00	$80	$0
The number of complex user interface screens					0.00	$80	$0
Output Files						$80	
The number of simple output files					0.00	$80	$0
The number of moderately complex output files					0.00	$80	$0
The number of complex output files.					0.00	$80	$0
Business Logic to Support Screens						$80	
The amount of simple business logic required to support the screen displays					0.00	$80	$0
The amount of moderately complex business logic required to support the screen displays					0.00	$80	$0
The amount of complex business logic required to support the screen displays					0.00	$80	$0
Business Logic to Support Process						$80	
The amount of simple business logic to support the process.					0.00	$80	$0
The amount of moderately complex business logic to support the process.					0.00	$80	$0
The amount of complex business logic to support the process.					0.00	$80	$0
Interfaces						$80	
Interfaces to other systems not under our control (list all that apply)					0.00	$80	$0
Total:					**0.00**		**$0**

Template Date: 12/13/00

Project Totals	
Software	$0
Other Cost	$0
	$0

In the Beginning – How it Worked

- Spreadsheet provided a convenient tool for organizing and documenting feature points as an expression of the size of the project.
- Number of feature points counted are entered into the cell under the column labeled “Number” next to the type of feature point counted.
- From there, optimistic, realistic, and pessimistic values measured in person-hours are entered, and used to compute an expected value, which is the number of person-hours that is should take to code the requirement communicated by the SCR.

Expected Value (EV)

EV = [Optimistic + 4(Realistic) + Pessimistic]/6

In the Beginning – How it Worked

- Spreadsheet allows estimator to define hourly rate and multiplies this rate by expected value computation, giving a cost.

- Expected value and cost for each type of feature point is summed by the spreadsheet, and becomes basis for estimate that is communicated to client, as well as scheduling tasks.

In the Beginning – Problems

- Spreadsheet estimated the number of person-hours it would take to perform coding.
- Process did not use IFPUG size definition
- Did not differentiate between:
  - Types of resources that would perform the work.
  - Spreadsheet also did not account for estimating risk.

Enhanced Tool – Estimating Spreadsheet

Application/Project/Change	Feature Points (L)	Feature Points (M)	Feature Points (H)	Staff months	Project Length in Months At Specified Staff Size	Cost (probablility 50%)	Cost + .5 Standard Deviation (probablity of 59%)	Cost + .8 Standard Deviation (probablity of 79%)	Cost + 1 Standard Deviation (probablity of 84%)	Cost + 1.3 Standard Deviation (probablity of 90%)
			0	0	0	$0.00	$0.00	$0.00	$0.00	$0.00
Totals	**0**	**0**	**0**	**0**	**0**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Productivity Median in Function Points per Staff Month: for Experienced Staff, Structured Methods, Ordinary Tools, High-Level Languages	40
Specified Staff Size	3
Average Cost per hour	$103.87
Hours in One Person Month	166.66
Estimated Spread	10.00%
Expected Value	0
Standard Deviation	0
.5 Standard Deviation	0
.8 Standard Deviation	0
1 Standard Deviation	0
1.3 Standard Deviation	0

Staff Months by SD Value
0
0
0
0

Enhanced Tool - Improvements

- Modifies how optimistic, realistic & pessimistic expected value variables are calculated.
- Expected value still computed in the same standard way, but yields feature points instead of person-hours, used.
- Number of feature points used to compute the cost of the project with
  - Average rate per hour,
  - Productivity
  - Number of person-hours in the organizations person-month.
- Optimistic value (L) comes from the sum total of function points.
- Realistic value (M) is entered by the estimator and is based on expert judgment.
- Pessimistic value (H) is computed via a percentage of the realistic value as entered by the estimator.

Enhanced Tool – Productivity Considerations

- Most important of these variables, productivity, is one of the variables used to estimate the cost.
- Productivity is based on Caper Jones [2] work in examining the data from more than 800 software projects between 1987 and 1995 regarding how much software development work may be completed in a person-month.

Enhanced Tool – Productivity Basis

- Jones' work uses the magnitude of four technical factors to express the expected. These factors are:

1. Inexperienced/Experienced Staff:
   - The level of experience of staff performing the work in the application being developed and the tools used for the development;
2. Unstructured/Structured Methods:
   - The usage, or lack thereof, of formal software development methods;
3. Ordinary/CASE Tools:
   - The use of ordinary or case tools, or the lack of their use;
4. Low/High Level Languages:
   - The use of high or low level programming languages.

Enhanced Tool – Productivity Basis

- Jones found that productivity:
  - Can be expressed by the number of function points that can be coded in a person-month
  - Varied depending on the magnitude of these factors
  - May be distributed across a range from low to median to highest, based on statistical data from the 800 projects he studied.

Enhanced Tool – Productivity Factor

- Once the estimator makes an assessment of these technology factors, and determines what the productivity factor should be, that factor is used to compute the cost.
- Therefore, as the estimator varies the productivity factor, which itself is varied by the magnitude of each of the four technology factors, the cost varies.
- Jones also found that 40 function points may be coded in one person-month as the four technology factors each approached their highest magnitude.

Enhanced Tool – Estimating Risk Reserve

- Further enhancement was developed to estimate risk reserve.
- Enhancement based on the work of Richard Stutzke[3].
- Stutzke asserts that if you can estimate the mean effort, and the standard deviation, then you can estimate the risk reserve.
- Using this, he established probabilities that the size of the project will not exceed the size value as depicted in Risk Reserve Table.

Enhanced Tool – Risk Reserve

Size Value	Probability That Size Will Not Exceed the Size Value
μ	50%
$\mu + 0.5\sigma$	59%
$\mu + 0.8\sigma$	79%
$\mu + 1.0\sigma$	84%
$\mu + 1.3\sigma$	90%

Enhanced Tool - Problems

- Did not define use standard function points.
- There was no way to differentiate the complexity of feature or function points.
- There was not a convenient way to document justification for feature or function point counts.
- Did not account for non-functional estimates.
- Did not allow for uncertainty adjustments associated with not having enough data to estimate.

Function Point Based Estimate Tool – Estimated Costs Summary

Probability	Total Cost	Total Person Hours	
Cost (probablility 50%)	$0.00	0.00	
Cost + .5 σ (probablity of 59%)	$0.00	0.00	
Cost + .8 σ (probablity of 79%)	$0.00	0.00	
Cost + 1 σ (probablity of 84%)	$0.00	0.00	
Cost + 1.3 σ (probablity of 90%)	$0.00	0.00	
Non-Functional Costs	$0.00	0.00	
Total Budget Recommendation	**$0.00**	**0.00**	**<------Recommended**

Function Point Based Estimate Tool – Estimated Costs Worksheet

Project Name	Optimistic	Average	Pessimistic	Staff months	Duration in Months At Specified Staff Size	Cost (probablility 50%)	Cost + .5 σ (probablity of 59%)	Cost + .8 σ (probablity of 79%)	Cost + 1 σ (probablity of 84%)	Cost + 1.3 σ (probablity of 90%)
Project name	0.00	0.00	0.00	0	0	$0.00	$0.00	$0.00	$0.00	$0.00
Totals	**0.00**	**0.00**	**0.00**	**0**	**0**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Productivity Coefficient in Function Points per Staff Month: for Experienced Staff, Structured Methods, Ordinary Tools, High-Level Languages	40
Specified Staff Size	1
Weighted Average Rate	$106.47
Hours in One Person Month	160
Estimated Hours for Project	0
Expected Value Spread	20.00%
Total Function Points From Worksheets	0
Expected Value in Function Points	0.00
Standard Deviation	0
.5 Standard Deviation	0
.8 Standard Deviation	0
1 Standard Deviation	0
1.3 Standard Deviation	0

	All SDLC Phases									
	Weighted Average Rate	**Hours**	**Hours + .5 σ**	**Hours + .8 σ**	**Hours + 1 σ**	**Hours + 1.3 σ**	**Cost**	**Cost + .5 σ**	**Cost + .8 σ**	**Cost + 1 σ**	**Cost + 1.3 σ**
Summary of Functional Costs & Effort	$106.47	0.00	0.00	0.00	0.00	0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Resource Type	Rate	Units
Senior Systems Analyst (2)	$95.00	1
Software Developer (2)	$115.00	1
Senior Web Applications Developer	$125.00	1
Software Tester (1)	$80.00	1
Project Manager	$150.00	0.25
Weighted Average----------->	**$106.47**	

Function Point Based Estimate Tool – Procedure [4]

- Conceptualize Use Cases
- Type Use Cases
- Identify Data (entity/attribute) Used by Use Case
- Document & Count Data Used by Use Case
- Account for Unknown

Function Point Based Estimate Tool – Function Point Template

Entities Referenced by External Output Use Cases	Entity Attributes			
		1 to 5	6 to 19	20+
	<2	4	4	5
	2 to 3	4	5	7
	>3	5	7	7

Entities Referenced by External Input Use Cases	Entity Attributes			
		1 to 4	5 to 15	16+
	<2	3	3	4
	2	3	4	6
	>2	4	6	6

Entities Referenced by Inquiry Use Cases	Entity Attributes			
		1 to 5	6 to 19	20+
	1	3	3	4
	2 to 3	3	4	6
	>3	4	6	6

Internal Logical Files	Entity Attributes			
		1 to 19	20 to 50	51+
	<2	7	7	10
	2 to 5	7	10	15
	>5	10	15	15

External Interface Files	Entity Attributes			
		1 to 19	20 to 50	51+
	<2	5	5	7
	2 to 5	5	7	10
	>5	7	10	10

Function Point Based Estimate Tool – Use Cases

Entities Referenced by External Output Use Cases	Entity Attributes			
		1 to 5	6 to 19	20+
	<2	4	4	5
	2 to 3	4	5	7
	>3	5	7	7

Entities Referenced by External Input Use Cases	Entity Attributes			
		1 to 4	5 to 15	16+
	<2	3	3	4
	2	3	4	6
	>2	4	6	6

Entities Referenced by Inquiry Use Cases	Entity Attributes			
		1 to 5	6 to 19	20+
	1	3	3	4
	2 to 3	3	4	6
	>3	4	6	6

Function Point Based Estimate Tool – Inquiry or Reports

						Total FP:	0
Report Name							
Entities Referenced by Inquiry Use Cases	**Entity Attributes**						
		1 to 5	**6 to 19**	**20+**			
	1	3	3	4			
	2 to 3	3	4	6			
	>3	4	6	6			
Table/Column support (table_name crossing domain(# of columns crossing domain)):							

Function Point Based Estimate Tool – Internal Logical Files

						Total FP:	0
ILF							
Internal Logical Files	Entity Attributes						
		1 to 19	20 to 50	51+			
	<2	7	7	10			
	2 to 5	7	10	10			
	>5	10	15	15			

Function Point Based Estimate Tool – External Interface Files

						Total FP:	0
EIF							

External Interface Files	Entity Attributes			
		1 to 19	20 to 50	51+
	<2	5	5	7
	2 to 5	5	7	10
	>5	7	10	10

Function Point Based Estimate Tool – Assumptions, Notes

Assumptions	Notes

Function Point Based Estimate Tool – Adjustment for Uncertainty of Requirements

Number of Function Point Types Accounted For	Range of Uncertainty
1	40%
2	20%
3	15%
4	10%
5	5%

Function Point Based Estimate

- Use of standard function point sizing methodology.
- All SDLC phases accounted for by a single worksheet.
- Near the bottom of the worksheet, we list the resources types that are involved in supporting the project along with their hourly rate and weighted average of the rate, the corresponding estimated effort by probability of exceeding that effort, and the corresponding estimated cost by probability of exceeding that cost.
- We are able to account for the uncertainty introduced by not having enough data to most accurately estimate.
- With these enhancements, we are able to examine and model our estimates across the project, and we are able to model estimates costs using different resource types.

Conclusion

- Enhancements to this process have enabled us to more accurately estimate size, which is directly related to better cost estimating, by using IFPUG standard function point analysis for size estimates, while also accounting for differing levels of risk by making use of Stutzke's research.

- We initially use Jones' research in software measurement to establish a baseline productivity. Future estimates must revise this productivity with historical data about the projects actual performance, in order for cost estimates to be as accurate as possible.

References

[1] Thomset, Rob, *Third Wave Project Management – A Handbook for Managing the Complex Information Systems for the 1990s*, Yourdon Press Computing Series, 1989

[2] Jones, Capers, *Applied Software Measurement, Assuring Productivity and Quality,* pages 244 – 248; 1997

[3] Stutzke, Richard; *Estimating Software-Intensive Systems, Projects, Products, and Processes,* pages 117 – 119; 2005

[4] Dekkers, Carol; Quality Plus Technologies and www.ifpug.org

Questions and Further Information

Contact Information

William D Hart, PMP
President and Chief Project Officer
Soft Solutions Consulting, Inc.
8373 Piney Orchard Parkway
Suite 302
Odenton, MD 21113
P: 410.672.3700
C: 410.456.2295
F: 209.231.7936
wmdhart@softsolution.net
http://softsolution.net