The Use of Function Points for Software Estimation and Measurement

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Sandia National Laboratories

Five Function Point-related Topics

- **Quick hits on Function Points – primer**
- **Now that you know everything, an example**
- **Using measurements throughout the life of the project**
- **Impact on process maturity (CMMI®)**
- **Unique measurement opportunity?**

Function Point Facts

The most widely used standard software size metric throughout industry is Function Points.

Capers Jones of Software Productivity Research refers to the use of lines of code for measurement as professional malpractice.

Function Points are now an ISO/IEC standard. (20926 date: 11/03)

Function Points were first developed in 1979.

Statistical analysis has demonstrated the integrity of Function Point counting by trained counters.

Function Point counting incorporates the following principles:

- **count all the functionality provided to the customer**
- **count only the functionality provided to the customer**
- **counting must be independent of technology**

A CFPS is a Certified Function Point Specialist (3-part exam) administered by IFPUG.

Function Point Facts (cont'd)

According to Capers Jones, Function Point usage reduces the risk of:

- project termination,
- litigation for breech of contract,
- unstable requirements,
- poor quality, and
- cost and schedule overruns

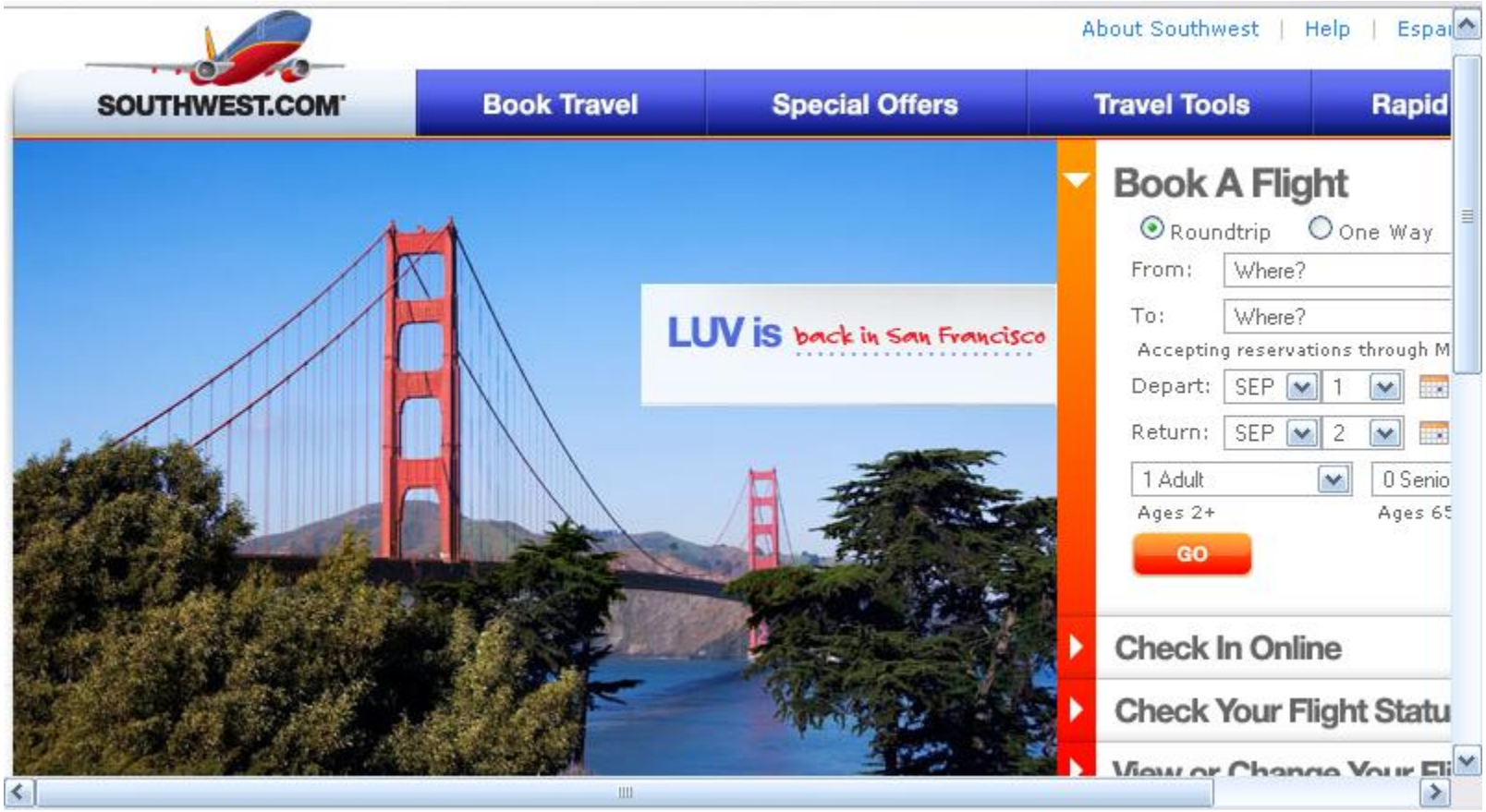
Function Points are calculated by counting screens, reports, queries, and files / database tables / objects. These are known in FP parlance as:

- External Inputs,
- External Outputs,
- External Inquiries,
- Internal Logical Files, and
- External Logical Files.

According to Capers Jones projects with function point analysis:

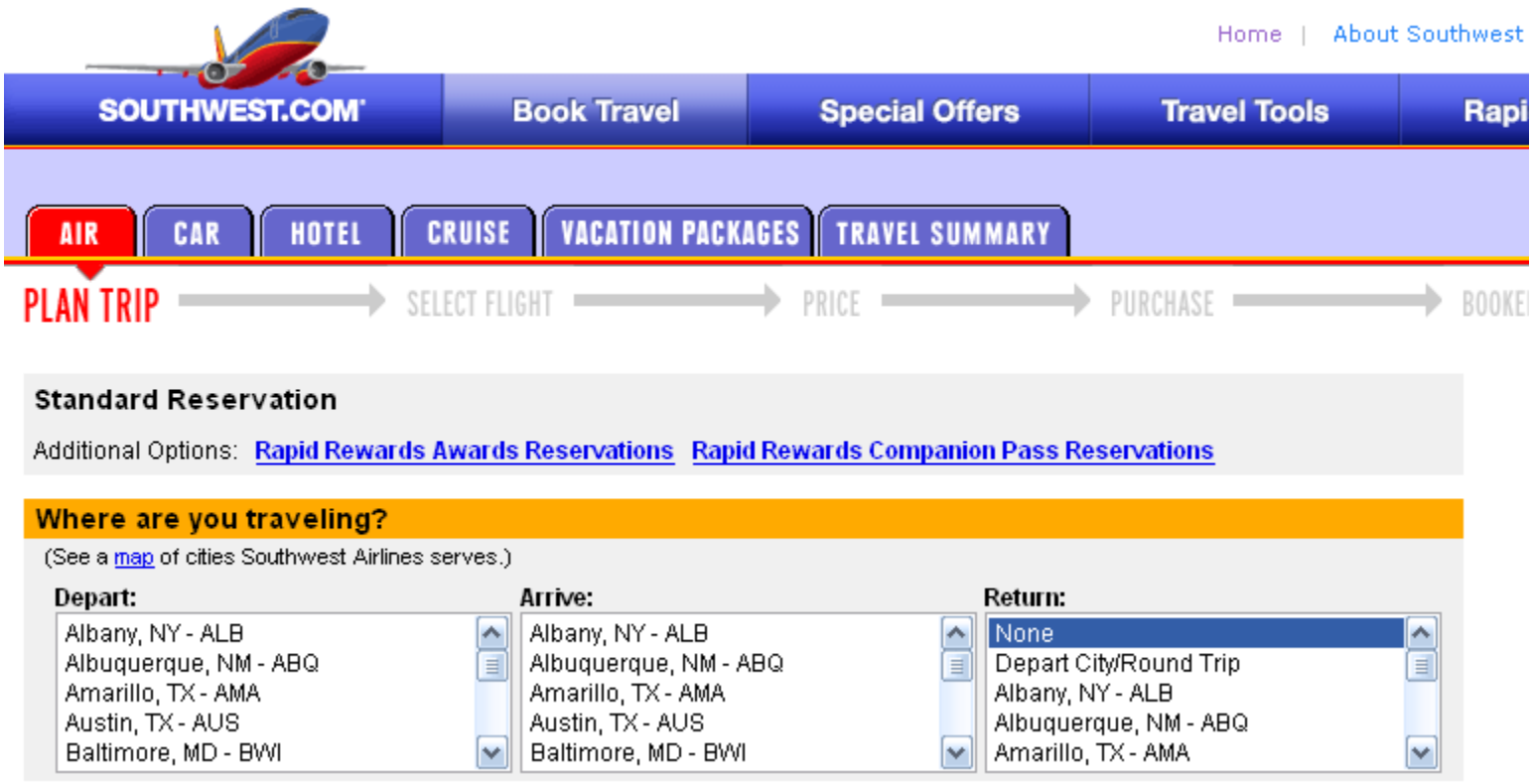
- have less scope creep
- have about 15% lower cost overruns
- have about 25% less schedule slips
- save between $25 and $75 per function point

A Function Point Example



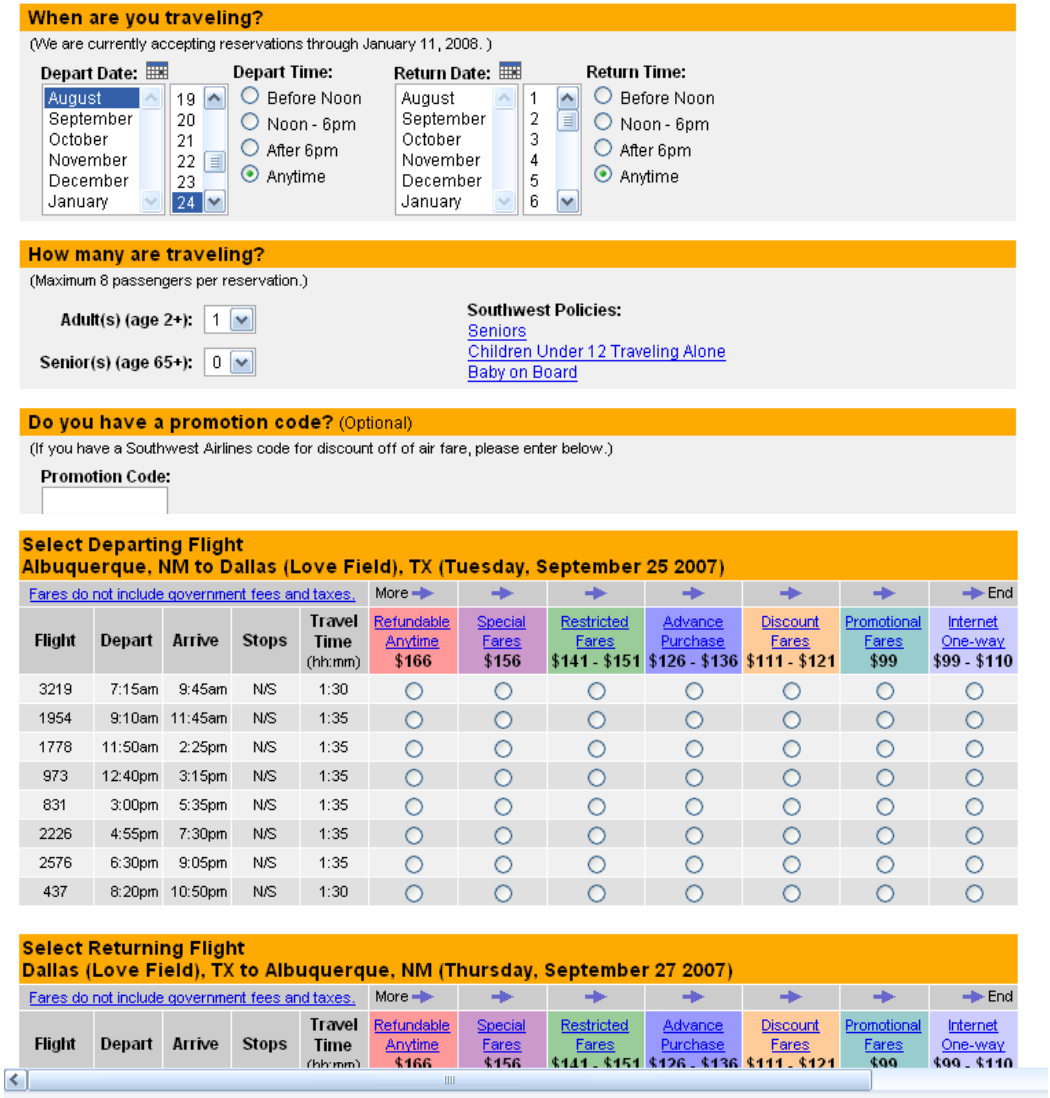
This screen contains no data that is maintained in data structures (partial assumption). It's purpose is for navigational. Navigational interfaces without persistent data have no Function Points.

A Function Point Example (cont'd)



This screen as shown (apparently) queries a data structure and creates a list of cities served by SWA. An ILF and an EQ are evident.

A Function Point Example – (cont'd)



When are you traveling?

(We are currently accepting reservations through January 11, 2008.)

Depart Date:		Depart Time:	Return Date:		Return Time:
August	19	Before Noon	August	1	Before Noon
September	20	Noon - 6pm	September	2	Noon - 6pm
October	21	After 6pm	October	3	After 6pm
November	22	Anytime	November	4	Anytime
December	23		December	5	
January	24		January	6	

How many are traveling?

(Maximum 8 passengers per reservation.)

Adult(s) (age 2+): 1

Senior(s) (age 65+): 0

Southwest Policies:
Seniors
Children Under 12 Traveling Alone
Baby on Board

Do you have a promotion code? (Optional)

(If you have a Southwest Airlines code for discount off of air fare, please enter below.)

Promotion Code:

Select Departing Flight
Albuquerque, NM to Dallas (Love Field), TX (Tuesday, September 25 2007)

Fares do not include government fees and taxes. More → End

Flight	Depart	Arrive	Stops	Travel Time (hh:mm)	Refundable Anytime $166	Special Fares $156	Restricted Fares $141 - $151	Advance Purchase $126 - $136	Discount Fares $111 - $121	Promotional Fares $99	Internet One-way $99 - $110
3219	7:15am	9:45am	N/S	1:30	○	○	○	○	○	○	○
1954	9:10am	11:45am	N/S	1:35	○	○	○	○	○	○	○
1778	11:50am	2:25pm	N/S	1:35	○	○	○	○	○	○	○
973	12:40pm	3:15pm	N/S	1:35	○	○	○	○	○	○	○
831	3:00pm	5:35pm	N/S	1:35	○	○	○	○	○	○	○
2226	4:55pm	7:30pm	N/S	1:35	○	○	○	○	○	○	○
2576	6:30pm	9:05pm	N/S	1:35	○	○	○	○	○	○	○
437	8:20pm	10:50pm	N/S	1:30	○	○	○	○	○	○	○

Select Returning Flight
Dallas (Love Field), TX to Albuquerque, NM (Thursday, September 27 2007)

Fares do not include government fees and taxes. More → End

Flight	Depart	Arrive	Stops	Travel Time (hh:mm)	Refundable Anytime $166	Special Fares $156	Restricted Fares $141 - $151	Advance Purchase $126 - $136	Discount Fares $111 - $121	Promotional Fares $99	Internet One-way $99 - $110

This screen as shown (apparently) queries a data structure and creates a list of flights within a destination. An ILF and an EQ are evident. No selection of options on this screen are counted until an attempt is made to purchase the tickets (that is, the transaction is complete from an elementary process view).

A Function Point Example – (cont'd)

Southwest Airlines Air Itinerary and Pricing

Air Itinerary

Trip	Date	Day	Stops	Routing	Flight	Routing Details
Depart	Sep 25	Tue	N/S	ABQ-DAL	3219	Depart Albuquerque (ABQ) at 7:15 AM Arrive in Dallas (DAL) at 9:45 AM
Return	Sep 27	Thu	N/S	DAL-ABQ	2217	Depart Dallas (DAL) at 6:15 PM Arrive in Albuquerque (ABQ) at 7:00 PM

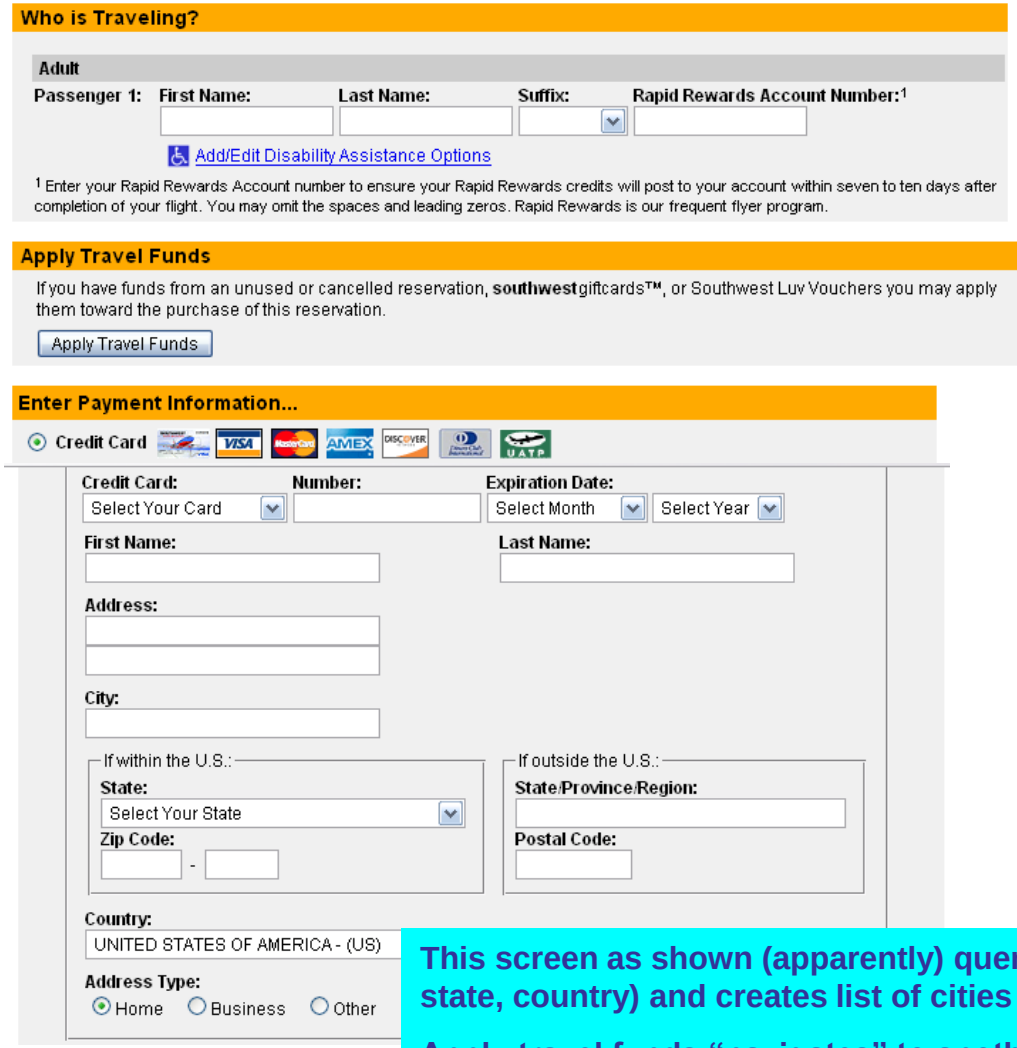
Pricing

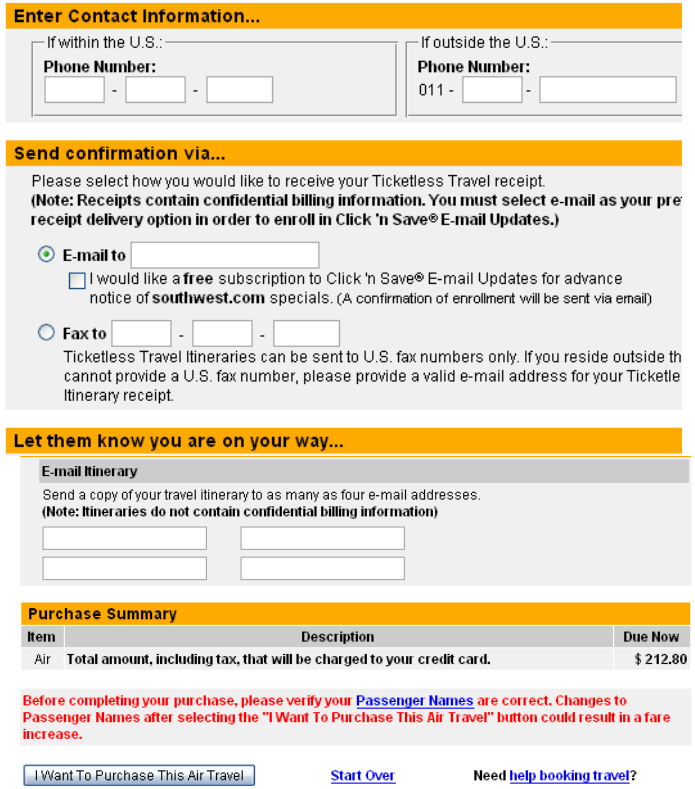
Passenger Type	Trip	Routing	Type of Fare	Base Fare	U.S. Taxes	PFC	Security Fee[1]	Passenger(s)	Total
Adult	**Depart**	ABQ-DAL	Promotional Any Time	$92.09	$10.31	$3.00	$2.50	1	$107.90
	Return	DAL-ABQ	Promotional Any Time	$92.09	$10.31	$0.00	$2.50	1	$104.90
			Total	**$184.18**	**$20.62**	**$3.00**	**$5.00**		**$212.80**

[1] Security Fee is the government-imposed September 11th Security Fee.

This screen confirms a transaction that is about to take place. No new data structures are involved yet, but because of the sums in the bottom row this "screen" is an EO (not an EQ).

A Function Point Example – (cont'd)





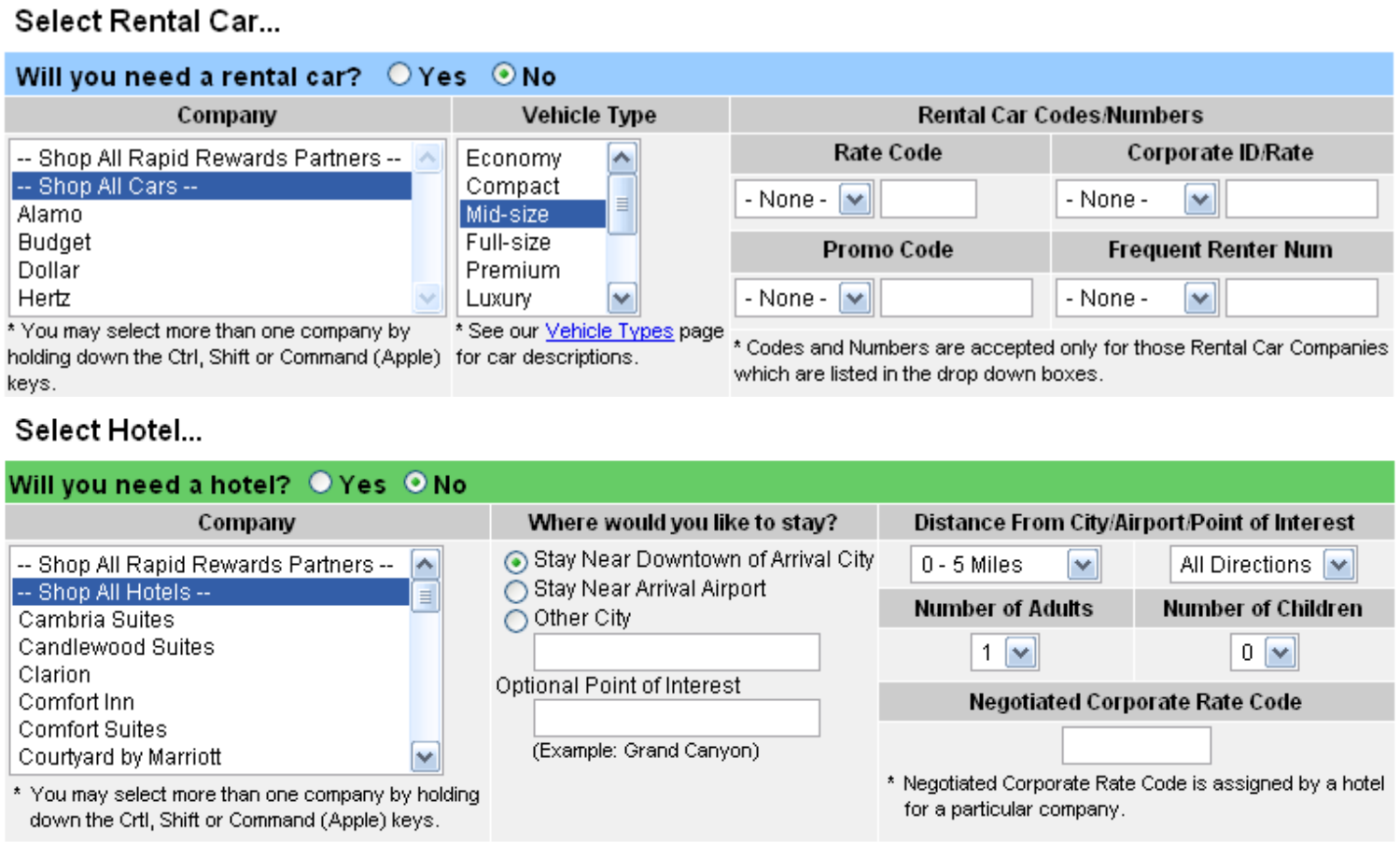
This screen as shown (apparently) queries several data structures (credit card type, state, country) and creates list of cities served by SWA. Three ILFs and EQs are evident.

Apply travel funds "navigates" to another query.

A Rapid Rewards query is also triggered upon name entry; potentially another ILF and certainly an EQ.

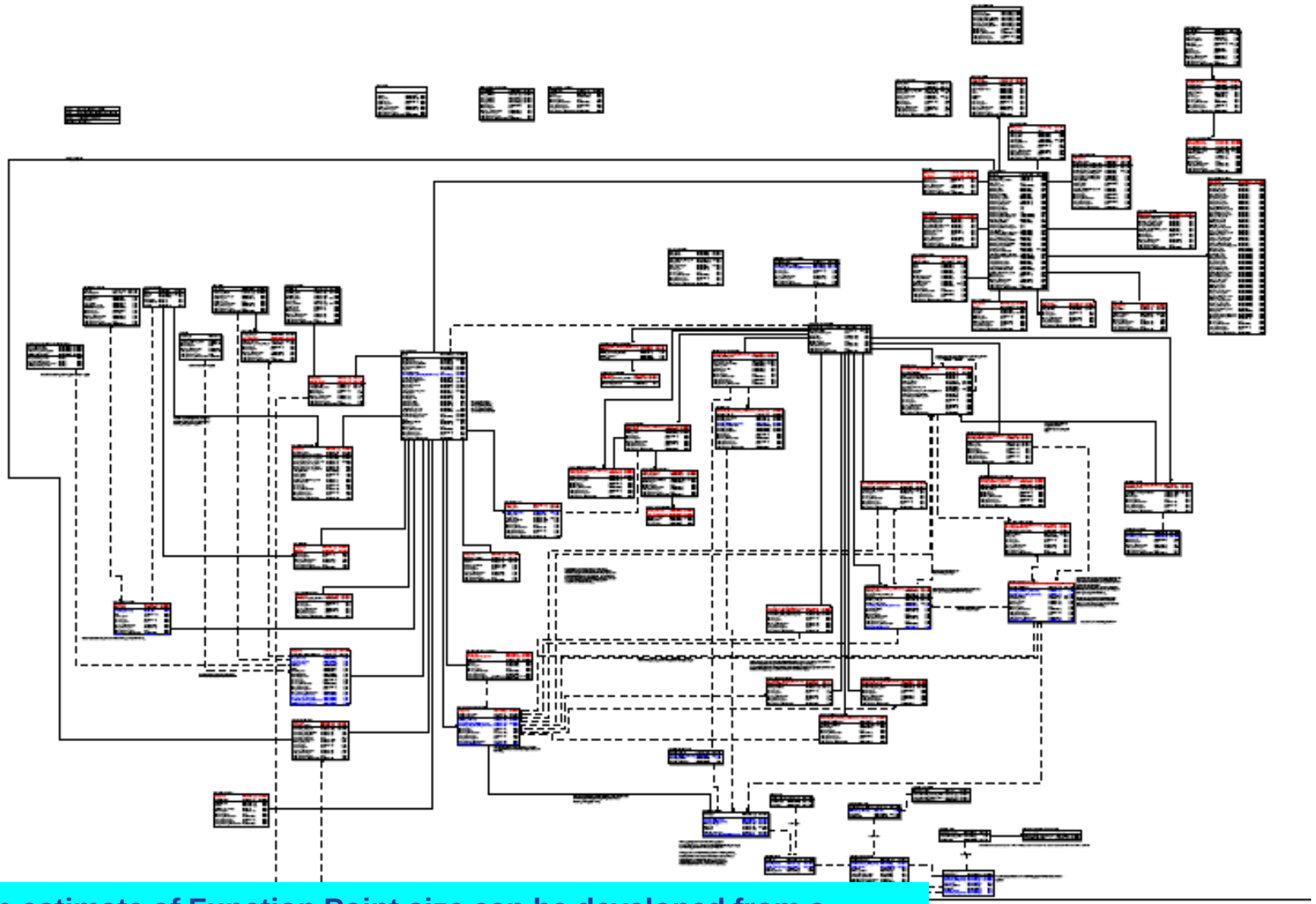
Eventually when clicking "I Want to Purchase this Air Travel" and EI will stored this transaction in a new ILF and also trigger itinerary distribution which as EQs.

A Function Point Example – (cont'd)



A similar series of event occurs for rental cars and hotels; I'll spare you.

Using a Data Model to Estimate Function Points



An estimate of Function Point size can be developed from a simple data model. First remove disqualified files as ILFs, and then multiple by . . .

A Measurement Life Cycle

	FPAW	QDE	Estimation Worksheet	FP Counting Worksheet
Purpose	Rough size value in Function Points	Rough size, cost, and FTE values	Firm size and resource estimate	Tally and document Function Point counts
Triggers are	Proposal, CRs, Enhancements	Proposal in lieu of detailed project planning data	Data Model, External Interfaces Definition	Product Release for actual Data Model & External Interfaces Definition for estimates
When in Lifecycle	During early plan and throughout lifecycle when requirements change	Planning	Design	Design through Operations
Risk Impact to Project	Higher risk due to uncertainty about product	Higher risk due to uncertainty about product	Minimal risk as functionality is solidified	No risk as product is finished - values are used to improve future estimates
Typically used by	Trained project leader	Trained project leader	Trained project leader	Trained FP counter in conjunction with project team

FPAW – Function Point Approximation Worksheet

QDE – Quick ‘n Dirty Estimate

Approximate during Proposal Discussions

Function Point Approximation Worksheet

Contact: Questions concerng this worksheet may be directed to Joe Schofield

Purpose: This approximation (approximate when you aren't quite ready to estimate) worksheet supplements the SILC estimation worksheet by providin
estimate for the product requirements using Function Points. No knowledge of Function Point counting is required!
The values generated by this worksheet are used in conjunction with the approximation worksheet as a second dimension to approximating product siz

When to use: As part of planning / replanning and when the project team has an understanding on the types of objects / entitties that the product will s
and the functions that are likely to be needed in the product.

How to use: (the derived values in this spreadsheet use medium complexity values, IFPUG 4.2 2004)

Enter in the Logical Files column the logical data groupings (call these entities or objects) from the customer's perspecti… maintained (adde
For each logical data set, identify the likely functions to be performed on the logcial data groupings Enter a "y" un… for Create, Update, De
Enter in the Logical Files column the logical data groupings (call these entities or objects) from the customer'… , that will be interfaced from c
for editing or reporting.
For each logical data set directly above, enter a "y" under the column for Read.

Approximate

What you'll get: An approximated Function Point count that will treat your input as medium complexity Function Point types. This number will NOT likely
in the Approximation Worksheet since your requirements understanding is still likely yet to evolve.

Limitations: This spreadsheet is designed to work for up to 80 data sets; though it could be easily changed to accommodate more.

6	2	4	1	3

		Data Functions			Your Approximated Function Point Coun
Logical Files	**Create**	**Update**	**Delete**	**Read**	100
Hotels				y	
Car Rentals		y	y		
Trips	y	y		y	
Travelers		y			
Reservations	y				
Airlines					

Can also be used throughout the lifecycle to measure requirements size change!

The *QDE* provides a ballpark range when you know as few as one of three project variables

			QDE Worksheet		
Note: the resulting numbers derived from this worksheet will place your project at a medium or hi					vel of
until detailed estimates are derived using the SILC Estimating Process.					
Enter Labor Dollars:	200000.00				
Estimated Function Point Size	432.90				
Estimated Cycle Time needed	25.46	person months			
Enter Person Months	25.00				
Estimated Function Point Size	425.00				
Estimated Labor Dollars	196350.00				
Enter Function Points	433.00				
Estimated Labor Dollars needed	200046.00				
Estimated Cycle Time needed	25.47	Person months			

Approximate

Estimates are based on historic organizational performance

During planning, real resources and costs can be used to provide a range of expected results

Project Plan Estimating Worksheet

Steps: input attributes are shaded

[1]person experience levels
[2]person participation levels
[3]duration in years
[4]person labor rates
[5]SILC phase reliability variance (.4, .3, .2, .1, or 0)
[6]estimated size of project
[7]other costs (optional)

In return you receive:

[a]person experience efficiency
[b]FP contribution efficiency
[c]person & team cost rates
[d]estimated team FPs per month
[e]estimated cycle time
[f]estimated product costs (compare to planned)
[g]optimistic and pessimistic variance range

Experience Factors:	Expert	Mature	Rookie
Technology	0.80	1.00	1.30
Methodology	0.80	1.00	1.30
Application	0.80	1.00	1.30

Estimate

	Experience with . . .									
Resource	[1]Technology	[1]Methodology	[1]Application	[a]Experience Efficiency	[2]Participation	[b]FP Contribution Efficiency	[3]Du…	Average Labor Rate	[c]Annual Person Rate	[c]Total Person Cost
Person1	1.30	1.30	1.00	1.69	0.08	0.90	0.25	180,000	14,400	3,600
Person2	1.30	1.30	1.00	1.69	0.16	1.80	0.25	180,000	28,800	7,200
Person3	1.00	1.30	1.00	1.30	0.68	9.94	0.25	180,000	122,400	30,600
Person4	1.00	0.80	1.00	0.80	0.12	2.85	0.25	180,000	21,600	5,400
Person5	0.80	0.80	1.30	0.83	0.03	0.57	0.25	180,000	4,500	1,125
Person6	1.00	1.30	1.00	1.30	0.37	5.41	0.25	180,000	66,600	16,650
Totals					1.44	21.47		1,080,000	258,300	64,575
Team Avg. Monthly Efficiency						14.96				

	[g]Optimistic	Nominal	[g]Pessimistic
[5]Project Phase Reliability Variance		0.4	
[6]Project Size (Estimated Function Point	84	140	196
Historic FPPPM Metric	19	19	19
[d]Calculated team FPs per month (predi	21	21	21
[e]Cycle time (months - predicted)	4	7	9
[f]Product Cost (predicted)	84234	140389	196545
[f]Product Cost (planned)	64575	64575	64575
[7]Other Costs	0		0

Reliability Variances

SILC Phase	
Plan	0.40
Analysis	0.30
Design	0.20
Implement.	0.10
Operations	0.00

ILF = 28 FPs
EIF = ~72 FPs

Subject to change as the project undergoes change!

Actual Function Point counts are performed based on delivered product

	Low	Average	High	Total
[1]Internal Logical Files				0
[2]External Interface Files				0
[3]External Inputs				0
[3]External Outputs				0
[3]External Inquiries				0
Total Unadjusted Function Points (UFPs)				0
[4]Total Function Points				

14 System Characteristics (use IFPUG Counting Practices Manual 4.1)

Data Communications		Online Update	
Distributed Data Processing		Complex Pro[illegible]ing	
Performance		Reusabi[illegible]	
Heavily Used Configuration		In[illegible]	
Transaction Rate		[illegible] Ease	
Online Data Entry		[illegible]ple Sites	
End-User Efficiency		Facilitate Change	

Count Actuals

Actuals can be compared to estimates to determine variance, noting approved changes to baselines where applicable.

Usage:

Contact the SQA Group immediately if you don't know how to complete any of the information on this worksheet!

Use this worksheet to estimate Function Points given identified SILC artifacts AND upon project completion to derive an "actual" size.

Enter the number of low, average, & high Function Point types (ILFs, EIFs, EIs, EOs, EQs) - The worksheet will generate the totals

[1]These values are derivable from the information model.

[2]These values are derivable from the external interface model.

[3]These values are derivable from the presentation layer.

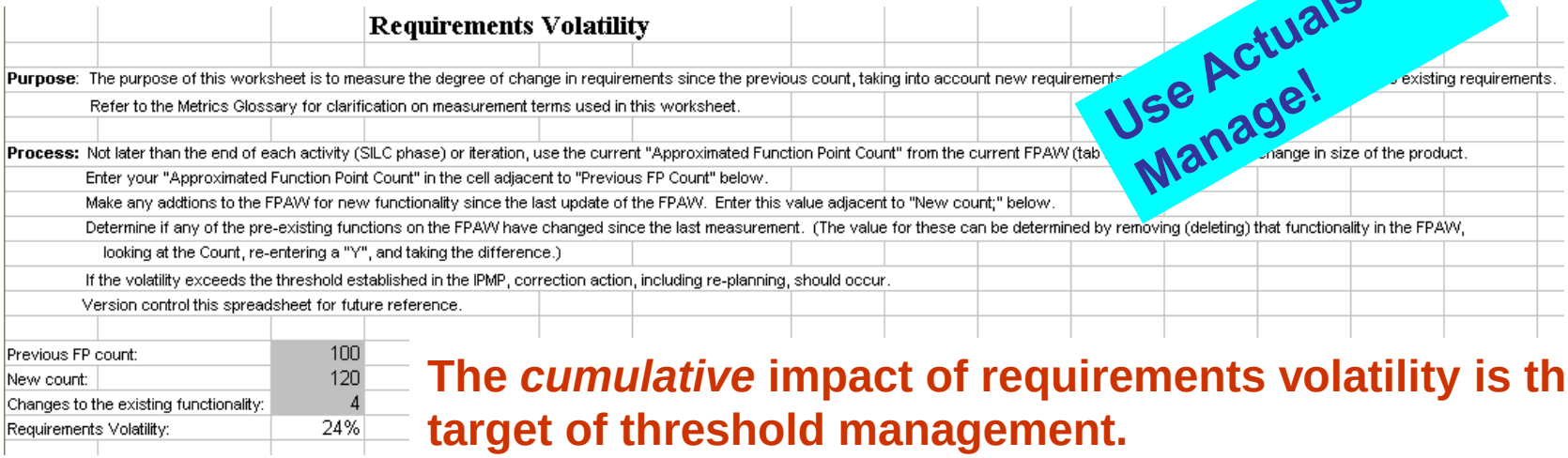
[4]Use this number for estimating the Function Point size on the Estimation Worksheet.

Enter a value between 0 and 5 for each of the 14 System Characteristics - The worksheet will sum these as multiply them against the UFPs

(Optionally) Enter additional values below to calculate some key project metrics:

Enter project labor costs		$ per FP:	#DIV/0!
Enter project defects (at implementation)		Defect per FP:	#DIV/0!
Enter project labor hours		Cycle time per FP	#DIV/0!

Actual Function Point counts are performed based on delivered product



Requirements Volatility

Purpose: The purpose of this worksheet is to measure the degree of change in requirements since the previous count, taking into account new requirements existing requirements.

Refer to the Metrics Glossary for clarification on measurement terms used in this worksheet.

Process: Not later than the end of each activity (SILC phase) or iteration, use the current "Approximated Function Point Count" from the current FPAW (tab hange in size of the product.

Enter your "Approximated Function Point Count" in the cell adjacent to "Previous FP Count" below.

Make any addtions to the FPAW for new functionality since the last update of the FPAW. Enter this value adjacent to "New count;" below.

Determine if any of the pre-existing functions on the FPAW have changed since the last measurement. (The value for these can be determined by removing (deleting) that functionality in the FPAW, looking at the Count, re-entering a "Y", and taking the difference.)

If the volatility exceeds the threshold established in the IPMP, correction action, including re-planning, should occur.

Version control this spreadsheet for future reference.

Previous FP count:	100
New count:	120
Changes to the existing functionality:	4
Requirements Volatility:	24%

Use Actuals to Manage!

The *cumulative* impact of requirements volatility is the target of threshold management.

Function Points can contribute to the following highlighted MA practices

Measurement and Analysis (ML2, Support)

. . . develop and sustain a measurement capability that is used to support management information needs.

SP 1.1 Establish Measurement Objectives
SP 1.2 Specify Measures
SP 1.3 Specify Data Collection and Storage Procedures
SP 1.4 Specify Analysis Procedures
SP 2.1 Collect Measurement Data
SP 2.2 Analyze Measurement Data
SP 2.3 Store Data and Results

SP 2.4 Communicate Results

Function Points can contribute to the following highlighted REQM practices

Requirements Management (ML2, Engineering)

. . . manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products.

SP 1.1 Obtain an Understanding of Requirements
SP 1.2 Obtain Commitment to Requirements
SP 1.3 Manage Requirements Changes
SP 1.4 Maintain Bidirectional Traceability of Requirements
SP 1.5 Identify Inconsistencies Between Project Work and Requirements

Function Points can contribute to the following highlighted PP practices

Project Planning (ML2, Project Management)

. . . establish and maintain plans that define project activities.

SP 1.1 Estimate the Scope of the Project
SP 1.2 Establish Estimates of Work Product and Task Attributes
SP 1.3 Define Project Lifecycle
SP 1.4 Determine Estimates of Effort and Cost
SP 2.1 Establish the Budget and Schedule
SP 2.2 Identify Project Risks
SP 2.3 Plan for Data Management
SP 2.4 Plan for Project Resources
SP 2.5 Plan for Needed Knowledge and Skills
SP 2.6 Plan Stakeholder Involvement
SP 2.7 Establish the Project Plan
SP 3.1 Review Plans that Affect the Project
SP 3.2 Reconcile Work and Resource Levels
SP 3.3 Obtain Plan Commitment

Function Points can contribute to the following highlighted PMC practices

Project Monitoring and Control (ML2, Project Management)

. . . provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.

SP 1.1 Monitor Project Planning Parameters
SP 1.2 Monitor Commitments
SP 1.3 Monitor Project Risks
SP 1.4 Monitor Data Management
SP 1.5 Monitor Stakeholder Involvement
SP 1.6 Conduct Progress Reviews
SP 1.7 Conduct Milestone Reviews
SP 2.1 Analyze Issues
SP 2.2 Take Corrective Action
SP 2.3 Manage Corrective Action

Function Points can contribute to the following highlighted IPM practices

Integrated Project Management (ML3, Project Management)

. . . establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes.

SP 1.1 Establish the Project's Defined Process
SP 1.2 Use Organizational Process Assets for Planning Project Activities
SP 1.3 Establish the Project's Work Environment
SP 1.4 Integrate Plans
SP 1.5 Manage the Project Using the Integrated Plans
SP 1.6 Contribute to Organizational Process Assets

Function Points can contribute to the following highlighted QPM practices

Quantitative Project Management (ML4, Project Management)

. . . quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives.

SP 1.1 Establish the Project's Objectives
SP 1.2 Compose the Defined Process
SP 1.3 Select the Subprocesses that Will Be Statistically Managed
SP 1.4 Manage Project Performance
SP 2.1 Select Measures and Analytic Techniques
SP 2.2 Apply Statistical Methods to Understand Variation
SP 2.3 Monitor Performance of the Selected Subprocesses
SP 2.4 Record Statistical Management Data

Function Points can contribute to Generic Practices

GP 1.1 Perform Specific Practices
GP 2.1 Establish an Organizational Policy
GP 2.2 Plan the Process
GP 2.3 Provide Resources
GP 2.4 Assign Resources
GP 2.5 Train People
GP 2.6 Manage Configurations
GP 2.7 Identify and Involve Relevant Stakeholders
GP 2.8 Monitor and Control the Process
GP 2.9 Objectively Evaluate Adherence
GP 2.10 Review Status with Higher Level Management
GP 3.1 Establish a Defined Process
GP 3.2 Collect Improvement Information
GP 4.1 Establish Quantitative Objectives for the Process
GP 4.2 Stabilize Subprocess Performance
GP 5.1 Ensure Continuous Process Improvement
GP 5.2 Correct Root Cause of Problems

Advertised Objectives of this Session

Why Should I Care? What are Function Points?

What problem(s) am I solving with Function Points?

What are some useful Function Point metrics? (cost per Function Point, FPPPM, cycle time)

How can Function Points be used before I have a stable set of requirements?

How can Function Points enable me to better track project progress?

What threads through the CMMI exist for Function Points?

Are cost and schedule really the most likely constraints to impair project success?

And we do this because . . .

Measurements speak louder than opinions.

Function Points can be used for rational negotiation with customers and management (we call this insulation).

Unlike stock markets disclaimers, future performance can be predicted based on past performance given similar attributes.

Estimates can be made with higher levels of confidence than using new methods with each project.

You won't need to clean-up later and you won't need to be as charming! (see first comment above)