



Predictive Analytic Approaches for Estimating the Lifecycle Cost of Agile Software (SW) Programs

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TrueMapper



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Predictive Models Integration Framework Customer Data Mapping Basis-of- Access PCA Estimate Engine Generator from Excel

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### **Today's Presenter**





### **Richard Mabe** Solutions Consultant

- Over 40 years of operations analysis experience
  - Civil service employee and as a federal contractor
  - Specializing in logistics analysis and cost analysis for US government programs.
- Apply industry best-practices to estimate costs for Software development, cybersecurity and C4I systems integration.
- His experience includes hands-on data collection, cost estimating, and project management.
- Holds a BS Degree in Geology from Boise State University, and an MS in Logistics Management from AFIT.



### **Overview**

- Agile Processes
- Agile Characteristics Affecting a Cost Estimate
- Solving Agile Cost Estimating Issues with TruePlanning<sup>®</sup>
- Demonstration



## **Agile Processes**



## **Traditional (Linear) SW Development**

- Deliver the complete end-product at the completion of a detailed schedule (incremental, waterfall, etc ....)
  - Requirements are analyzed
  - Architecture and design are created
  - Requirements are sequentially implemented, tested and delivered
- Months (or longer) occur before there is a usable software capability for the customer to evaluate





## **Agile Incremental SW Development**

- SW capability is developed in smaller increments of defined minimum viable capabilities
- SW is delivered as completed, and can be deployed and implemented by the end user
  - Frequent and shorter time horizons (releases/program increments, sprints)
  - Requirements described with qualitative user stories
  - Each user story is sized to complete in a single iteration



- End users work closely with the SW team
  - Priorities/plans may shift from iteration to iteration as capability is delivered
  - Agile teams expect and embrace change



### **Agile Best Practices\***

- Pair programming
  - Two team members at one workstation; continuous coding and review)
- Continuous integration with automated testing
- Test driven development
  - Code to specific requirements keyed to test cases; code to pass the tests
- Daily stand-up meetings

#### \*Brief summary only. Estimates need to support these practices.



### **Agile Best Practices\***

- Co-located teams
- Code refactoring (with coding standards)
- Small releases
- Customer on team
- Simple design
- Sustainable pace

### \*Brief summary only. Estimates need to support these practices.



## **Agile Methodologies/Frameworks\***

- Kanban (Just in time production)
- Scrum (break project into sprints and manage one at a time)
- Extreme Programming (focus on continuous delivery using sprints)
- Feature Driven Development (create SW models every two weeks from a development and design plan)
  - Plan by Feature; Design by Feature; Build by Feature

#### \*Brief summary only. Estimates need to support these practices.

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## **Agile Methodologies/Frameworks\***

- Dynamic Systems Development (common framework for sprints)
  - Deliver on time; Collaborate; Develop iteratively;
     Communicate; Never compromise quality
- Crystal (a family of frameworks; tailor to team needs)
- Use "Lean" practices
  - Eliminate waste, Build quality in, Deliver fast, Respect people

### \*Brief summary only. Estimates need to support these practices.



## Agile Characteristics Affecting a Cost Estimate



### **Key Agile Characteristics Impacting Cost**

- Near term defined workload per increment (backlog)
  - Long term plan/map addressed just before each increment starts
- Daily schedules and dynamics (scrums, sprints)
  - No specific order or sequence for completion of the backlog
  - Specific decisions on what to accomplish occur daily
  - Cost estimator may be part of the daily decision to ensure dynamics are captured in the model
- Useable SW delivered when complete; all actions to complete are contained in the increment (release)
  - SW Teams assumed to work at a predictable velocity to complete random selection of backlog tasks (Completed SW / Unit Time)
- Effort measured in hours based on SW component sizing



## **Other Considerations Impacting Cost**

- Agile is a management paradigm, not a new way to write, compile or configure code
  - Regular software development activities still occur
  - Enhanced with automated testing, more user interaction and increased concurrency (parallel releases; combined DT/OT)
- Effort measured in hours, but still driven by relative "size" of the backlog items to complete
  - Hours = f(Size, Team Capability, SW Item Configuration and Complexity, etc ...)
  - Backlog per increment selected and sized to fit the increments (sprint, release)
  - Teams cannot do more than they are capable in the time box given
  - Capability not complete until integrated into a deliverable Feature which has been tested and approved for delivery
  - Defects slow down the process and add work to a Release time box
- "Solution" may be a hybrid approach some Agile, some waterfall

### **Cost Tools Need to Adapt**

### • Re-imagine SW Component Size

- Calibrate size measures with team velocity; flexible "effort / unit of time"
- Use qualitative measures to normalize for specific teams or increments (e.g., 1 Story Point = XXX LOC, or YYY Function Points, or whatever)

### • Include Agile Team Size

- Effort hours are constant; schedule hours decrease as team size increases
- Normalize on Iteration Length
  - Specify time per Release/Program Increment and Sprint within a Release
- Develop and report metrics related to time, velocity and delivered SW features
- Enhance with other team, project and program factors
  - Like any other software development project
  - Includes measures of productivity and complexity
- Estimator's job is to determine:
  - Hours required per backlog item and next level feature
  - Schedule feasibility does the time to complete an item fit the increment
  - Iterations required to achieve the minimum viable capabilities and minimum viable product
  - Uncertainty inherent for each SW backlog component and feature





## Solving Agile Cost Estimating Issues with TruePlanning®

## The PRICE<sup>®</sup> Paradigm



• The core TruePlanning<sup>®</sup> CERs take the general form of:

*Effort = SW Element Size x SW Program Consumption Rates* 

- Where:
  - Consumption Rates include measures of complexity and productivity, based on the SW operating environment, development team, development methods and other adjustments
  - Size includes New, Modified, Reused or Deleted code measured in a variety of code formats: SLOC, Function Points, Use Case Conversion Points, or custom size units specified by the user (such as story points)
- Organizations configure model inputs to drive the consumption rate values
  - Configure built-in "Calculators" to capture the appropriate ranges represented in the PRICE Database
  - Apply user specific data through TrueFindings<sup>®</sup> to create program specific values that override the PRICE Database

### **Enable with Agile Cost Objects**





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## Agile SW Component – Cost Drivers (Key Inputs)

### **Top 10 Cost Drivers**



### Sample Inputs for Agile

Start Date	6/1/2020	
Application Details		
Application Type	None 🖌 🗐	
Functional Complexity	6.00 🗸 🗐	
Operating Specification	1.400 💵	
Organizational Productivity	1.000 🗸 🗐	
Development Team Complexity	3.00 🖌 🗐	
Contract Service Options		
Development Service Options	In-House 💌	
Software Size		
Size Units	Custom Size Units 💌	
Custom Size Unit Name	Story Points √🗐	
<ol> <li>New Size</li> </ol>	50 🖌 🗐	
Agile Process Details		
Planning Cycle	Iterations/Sprints 💌	
Process Formality	Tailored Process 💌	
Length of Iteration or Sprint	2.00	weeks 💌
Agile Team Size	2.00	Full Time E
Software Requirements Stability	Fully Evolutionary 💌	
Customer Involvement	Full 💌	
Level of Rework Expected	Nominal 💌	

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### **Agile SW Component – Tailored Output**

	Costs : Agile SW Component: SW Item 1 n (Calibrated Team Capability) - [Agile Software Component] Currency in USD (\$) (as spent)		Total	FY2020
1	Agile SW Component: SW Item 1 n			
2		Iteration 0	2,453	2,453
3		Develop, Integrate, Test	16,740	16,740
4		Final Release, Test and Certification	3,708	3,708
5		Subtotal	22,901	22,901

	Metrics : Agile SW Component: SW Item 1n (Calibrated Team Capability) - [Agile Software Component] Currency in USD (\$) (as spent)	Value	Units
1	Total Cost	22,901	\$
2	Total Labor Hours	167.85	Hours
3	Development Summary		
4	Development Cost	22,901	\$
5	Development Labor Hours	167.85	Hours
6	Development Duration	0.53	Months
7	Agile Metrics		
8	Number of Iterations/Sprints	1	
9	Burn Down Rate	3,970.74	Size Units/Iteration
10	Agile Team Size	2.00	
11	Defects Injected Per Iteration/Sprint	50.36	Defects
12	Defects Removed Per Iteration/Sprint	43.06	Defects
13	Drivers		
14	Total Software Size	3,500	Source Lines of Code (SLOC)
15	Equivalent Source Lines of Code	1,550	
16	Custom Size Unit Details		
17	Custom Size Unit Name	Story Point	
18	Total Size in Custom Size Unit	175	Custom Size Unit
19	Number of Iterations/Sprints	1	
20	Burn Down Rate per Custom Size Unit	198.54	Custom Size Units/Iteration
21	Total Cost per Custom Size Unit	130.86	\$
22	Total Labor Per Custom Size Unit	0.96	Hours/Custom Size Unit
23	Development Cost Per Custom Size Unit	130.86	s

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## Agile Assembly Object – Cost Drivers (Key Inputs)

### **Top 10 Cost Drivers**

### Simple Estimate Input Screen



		Value		Units
1	Start Date			
2	System Description			
3	Operating Specification	1.400	+=	
4	Multiple Site Development	1.00	€⊞	
5	Functional Complexity	0.00	€3	
6	System Engineering Team Complexity	3.00	€	
7	System Engineering Organizational Productivity	1.000	<b>↓</b> ⊞	
8	Software External Integration Complexity	1.00	€33	
9	Hardware Software Integration Factor	0.00	€3	
10	System Complexity	25.00	€33	
11	System Engineering Agile Process Details			
12	Planning Cycle	Iterations/Sprints	$\mathbf{v}$	
13	Process Formality	Tailored Process	$\mathbf{v}$	
14	Release Cycle		4.00	months 💌
15	Software Requirements Stability	Fully Evolutionary	$\mathbf{v}$	
16	Customer Involvement	Full	$\mathbf{v}$	
17	Sequential Phasing	Some Overlap	$\mathbf{v}$	
18	Level of Rework Expected	High	$\mathbf{v}$	



## **Agile Assembly Object - Metrics**

	Costs : Agile Assembly: Feature 1 n (Single Capability; Deliverable SW) - [Agile Assembly] Currency in USD (\$) (as spent)		Total	FY2020
1	Agile Assembly: Feature 1 n (Single			
2		Release Planning	1,125	1,125
3		Requirements, Design and Integration	15,761	15,761
4		Release, Test and Certification	1,495	1,495
5		Subtotal	18,381	18,381
6	Agile SW Component: SW Item 1 n			
7		Iteration 0	2,453	2,453
8		Develop, Integrate, Test	16,740	16,740
9		Final Release, Test and Certification	3,708	3,708
10		Subtotal	22,901	22,901

Metrics : Agile Assembly: Feature 1 n (Single Capability; Deliverable SW) - [Agile Assembly] Currency in USD (\$) (as spent)	Value	Units
Total Cost	41,282	\$
Total Labor Hours	277.72	Hours
Development Summary		
Development Cost	41,282	\$
Development Labor Hours	277.72	Hours
Development Duration	3.00	Months
Agile Metrics		
Number of Releases	1.00	
Number of Iterations/Sprints	1	
Defects Injected Per Release	66.95	
Defects Removed Per Release	57.13	
Defects Injected Per Iteration/Sprint	75.96	
Defects Removed Per Iteration/Sprint	64.81	
Average Duration Per Iteration/Sprint	0.46	months
Bum Down Rate	3,970.74	Size Units/Iteration
Drivers		
Total Software Size	3,500	Source Lines of Code (SLOC)
Functional Complexity	6.00	
Equivalent Source Lines of Code	1,550	
	Metrics : Agile Assembly: Feature 1 n (Single Capability; Deliverable SW)- [Agile Assembly] Currency in USD (\$) (as spent)Total CostTotal Labor HoursDevelopment Summary Development CostDevelopment CostDevelopment DurationAgile MetricsNumber of ReleasesNumber of Iterations/SprintsDefects Injected Per ReleaseDefects Removed Per ReleaseDefects Removed Per Iteration/SprintAverage Duration Per Iteration/SprintBum Down RateDriversTotal Software SizeFunctional ComplexityEquivalent Source Lines of Code	Metrics : Agile Assembly: Feature 1 n (Single Capability: Deliverable SW) - [Agile Assembly] Currency in USD (\$) (as spent)ValueTotal Cost41,282Total Labor Hours277.72Development Summary41,282Development Cost41,282Development Labor Hours277.72Development Duration3.00Agile Metrics1Number of Releases1.00Number of Iterations/Sprints1Defects Injected Per Release66.95Defects Removed Per Release57.13Defects Removed Per Iteration/Sprint0.46Burn Down Rate3.970.74Drivers3.500Functional Complexity6.00Equivalent Source Lines of Code1.550





## **Demonstration**

### **Set Up Teams and Release Parameters**



- Start with a SW Object and create a "Team" capability:
  - Productivity
  - Velocity
  - SW Language
  - Other
- Build a library of objects that can be copied and pasted into a WBS as needed to assign workload to a Team
- Create a WBS reflecting the SW Program
  - SW Objects + IATC Objects
  - PM, SE, Test, Data, etc ....
  - Multiple Releases and Features
- Build the WBS iteratively:
  - One major SW object to estimate total size and required increments
  - Parse into smaller buckets summing to the same total size to create individual releases
  - Keep breaking down until the amount to be developed fits the planned time boxes

## **Demo – Initial Model**

### 1. Total High-Level Analogy of the Capability



- 2 week sprint time frame
- Evolving requirements
- Some customer involvement
- Nominal rework

Metrics : SW IATC (All Tasks; All Features) - [Agile Assembly] Currency in USD (\$) (in October, 2020)	Value	Units
Total Cost	4,548,221	s
Total Labor Hours	31,353.30	Hours
Development Summary		
Development Cost	4,548,221	s
Development Labor Hours	31,353.30	Hours
Development Duration	9.00	Months
Agile Metrics		
Number of Releases	3.00	
Number of Iterations/Sprints	9	
Metrics : SW Components/Tasks (All) - [Agile Software Component] Currency in USD (\$) (in October, 2020)	Value	Units
Total Cost	3,071,749	s
Total Cost Total Labor Hours	3,071,749 22,523.44	\$ Hours
Total Cost Total Labor Hours Development Summary	3,071,749 22,523.44	\$ Hours
Total Cost Total Labor Hours Development Summary Development Cost	3,071,749 22,523.44 3,071,749	\$ Hours \$
Total Cost Total Labor Hours Development Summary Development Cost Development Labor Hours	3,071,749 22,523.44 3,071,749 22 523.44	\$ Hours \$ Hours
Total Cost Total Labor Hours Development Summary Development Cost Development Labor Hours Development Duration	3,071,749 22,523.44 3,071,749 22,523.44 5.57	\$ Hours \$ Hours Months
Total Cost Total Labor Hours Development Summary Development Cost Development Labor Hours Development Duration Agile Metrics	3,071,749 22,523.44 3,071,749 22,523,44 5.57	\$ Hours \$ Hours Months

27,141.93 Size Units/Iteration

25.00



Burn Down Rate

Agile Team Size

## **Build-Up to an Objective Model**



#### 2. Divide into Releases and Features

	ı	Development Duration	6.00	Months		
Agile Program Example		Agile Metrics				
Overall Epic Story		rigite include				
PM PM: System Level PM and Epic Owner		Number of Releases	2.00			
SE: Solution Manager/Solution Engineer		Number of Iterations/Sprints	4			
IATC: Release Train Mgmt/Integration						
🖃 🚞 Minimum Viable Capability: Multi-Feature; Shared Team	lı					
SE: Release PM + SE		Development Duration	3.00	Months		
📮 💼 Release 1		Agile Metrics				
🗄 🧟 SW IATC (All Tasks; All Features)		Number of Releases	1.00			
SW Components (Adapted Culy-Fait 1)						
🚊 🖓 🔁 Release 2		Number of Iterations/Sprints	1			
🗄 🙍 SW IATC (All Tasks; All Features)	,					
SW Components (New Only)		Development Duration	3.00	Months		
SW Components (Reused)		Agile Metrics				
E. Release 3		Number of Releases	1.00			
🖻 🧑 SW IATC (All Tasks; All Features)						
SW Components (Adapted Only-Part 2)		Number of Iterations/Sprints	3			

### Created Features within a Release: - Same total SW size allocated to more items - Simultaneous development of SW items - Could not be completed in a single release Assumes (for example): - Same SW size allocated to Features - Sequential Releases

**Objective:** Finish all tasks and Features each within a one Release window

Release 1 still needs work to fit within a single release window



## Flexible/Expansible Objective Model



#### 3. Continue to Parse to Meet Release Limit



#### Added additional task to Feature 1:

- Same total SW size allocated to more items
- Simultaneous development of SW items
- Could not be completed in a single release

#### Meets the Objective



### **Questions?**





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