

## **Integrating Homegrown CERs in a Single Commercial Estimating Toolset**

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### **Introduction**

Estimating cost, schedule and risk of modern aerospace, defense and government systems is extremely challenging. These programs often invent things and push the state of the art to new levels. We can demystify the challenge by decomposing a system into major subsystems, often finding that the parts are more familiar than the whole. We find that for some components we have sound data from which we can build cost estimating relationships (CERS); while for others we must use other means. The best solution to an accurate estimate is to combine every technique in our arsenal: commercial models, public models and homegrown CERS. Homegrown CERs in the form of simple cost factors, equations, curves, and rules of thumb build confidence in estimates if they are derived from known, reliable data. However, most organizations have difficulty hosting, sharing and integrating their CERs with other estimating models. Homegrown CERs are commonly hosted in arcane Excel spreadsheets, and are not easily understood, audited or reused.

When there is no common framework, typical problems include:

- More cost estimating workforce money is spent on spreadsheet programming than on actual CER development
- Usually only one expert knows how to operate the model
- Models are spreadsheet-based and therefore difficult to distribute and collaborate
- Models are difficult to link to pricing systems, ERPs and other data sources
- Maintenance becomes more of a software effort than operations research (managing upgrades, GUI, reports,)
- Models are not easily audited

TruePlanning 2010, the latest generation in a long line of estimating solutions from PRICE Systems, integrates estimating models in a common collaborative framework. This paper demonstrates how homegrown cost estimating relationships can be quickly modeled in a standard framework that enables integration with commercially available models, internal systems and data sources. This paper quantifies the return on investment in this approach, emphasizing that the goal for any estimating organization is avoid tool development and to maximize workforce deployment in value-added activities such as data collection, analysis, and estimating.

The TruePlanning 2010 Alpha release presented is currently being piloted in several locations and is scheduled for release in 2010.



common data model allowing inter- and intra-estimate analysis, leveraging all existing data to the maximum.

### **Battlefield System Estimate**

The power of an integrated framework can be demonstrated by examining an estimate created with TruePlanning. The estimate is for a conceptual battlefield system consisting of a small UAV and a military ground vehicle outfitted with command and communication equipment, shown in the Figure 2. The mission is to scan a hostile environment and identify enemy (red) forces.



Figure 2: The Battlefield System

As the estimating organization plans their approach, they are comfortable using calibrated PRICE models for most of the hardware, software, and network components. For some components, the analyst prefers using homegrown cost estimating relationships. The TruePlanning screenshots in Figures 3 - 9 give insight into the estimate approach.

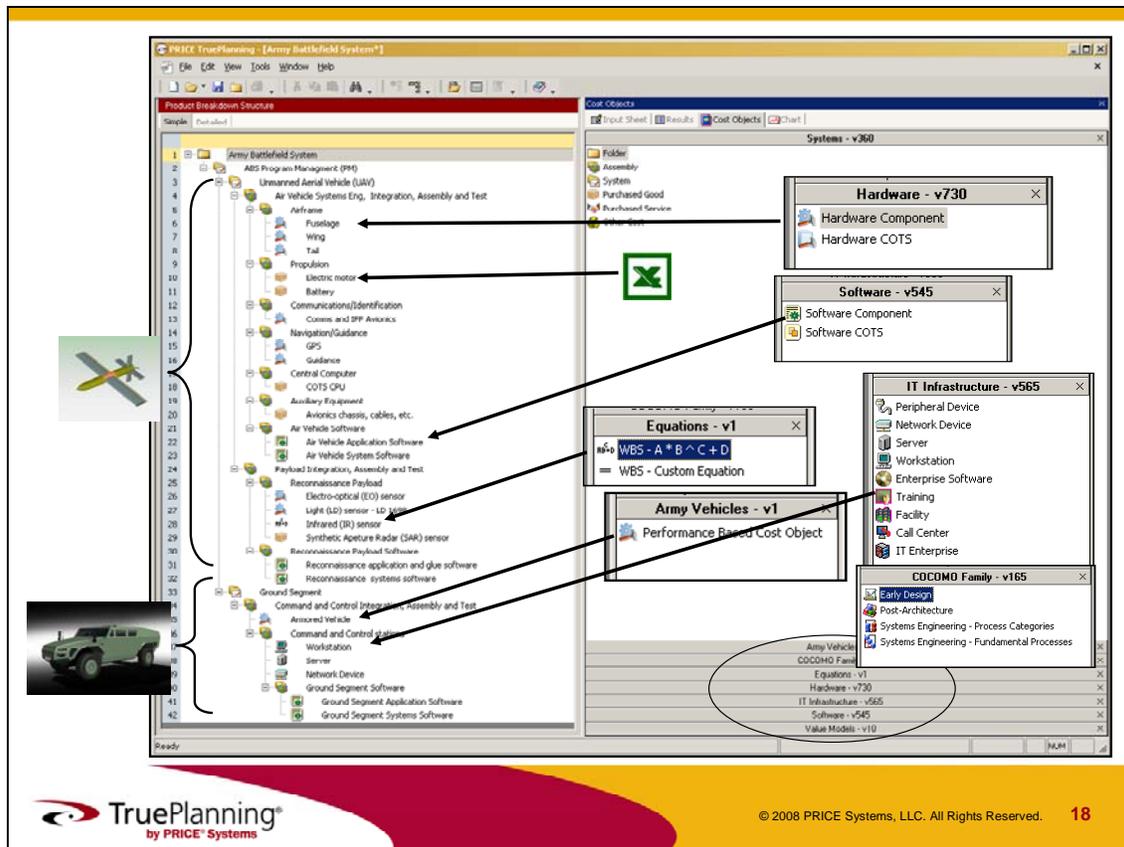


Figure 3: Battlefield System Estimate Product Breakdown Structure and Model Catalogs

Figure 3 shows the Battlefield System product breakdown structure (PBS) on the left panel and a rich set of model catalogs on the right. The analyst built the PBS by dragging models from the catalogs to the desired position in the tree on the left. Each element of the PBS is represented by an icon identifying the model used for the estimate. The Airframe components are estimated with PRICE hardware models, the Propulsion Electric Motor with an Excel model, the Air Vehicle software with PRICE software models, the Reconnaissance Infrared Sensor with a simple CER in a TruePlanning CER component, the Armored Vehicle with a complex homegrown CER hosted with TrueAnalyst, and the Command and Control network with PRICE IT models.

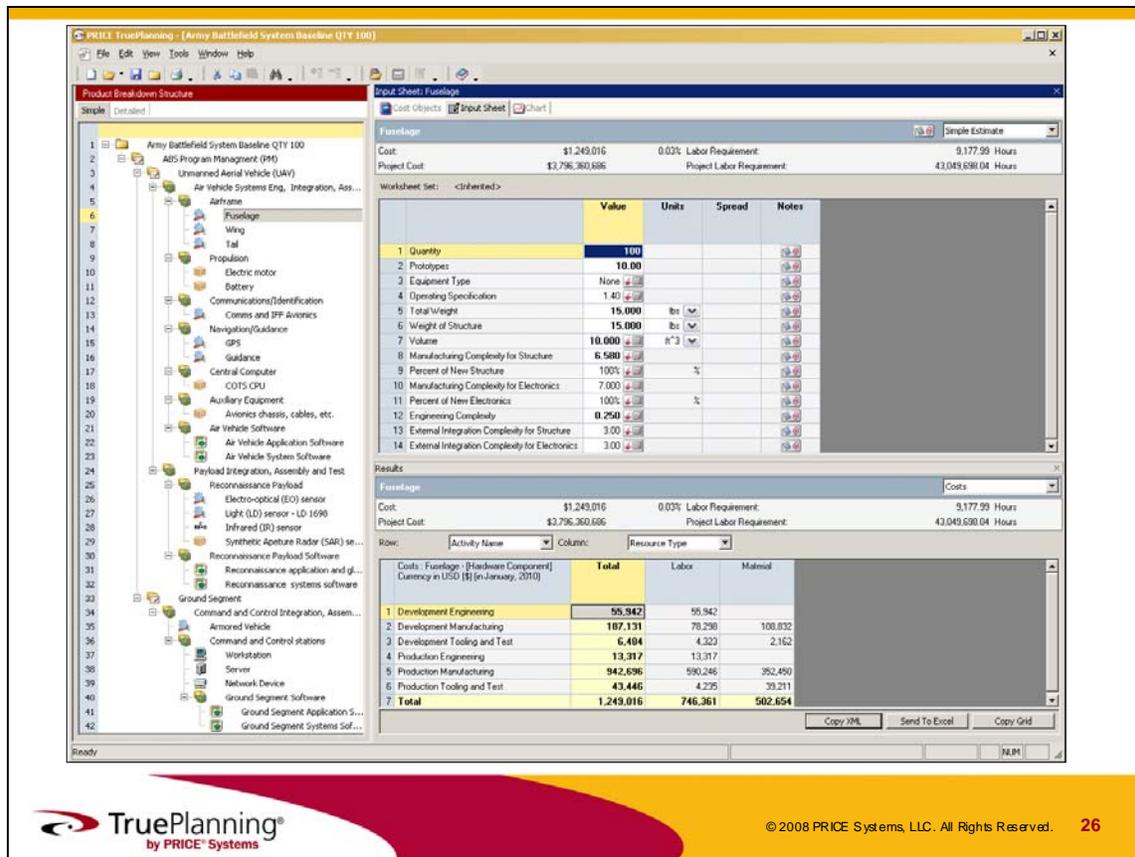


Figure 4: Airframe Fuselage estimated with PRICE Hardware Model

Figure 4 explodes the view for the Airframe Fuselage estimated with the PRICE Hardware Model. Manufacturing complexity values were measured from analogous structures to capture the material and construction technology. Input parameters and estimated costs can be viewed simultaneously so that cost driver sensitivity can be easily evaluated.

The screenshot displays the PRICE TruePlanning interface for an 'Army Battlefield System'. On the left, a 'Product Breakdown Structure' tree lists various components, with 'Electric motor' selected. The main window shows an 'Input Sheet: Electric motor' with a summary table and a detailed parameter table. An embedded Microsoft Excel window, titled 'Copy of Electric Engine Model.xls', shows the underlying spreadsheet model with parameters like Torque, Horsepower, and Reliability, and calculated values for Unit Cost and O&S Cost.

Item	Value	Units	Spread
1 Quantity	100		
2 Quantity Next Higher Assembly		1	
3 Unit Cost	1,990.19		\$
4 Prototypes	10.00		
5 Prototype Cost	0.00		\$
6 Scrap Rate Percentage			
7			
8 Economic Base Year For Development	1/1/2010		
9 Economic Base Year For Production	1/1/2010		
10 Operation and Support Unit Cost	398,037.63		
11 External Integration Complexity	3.00		

Row	Parameter	Value
4	Torque(lbs/ft)	200
5	Horsepower	80
6	Reliability(hrs)	1000
7	Ruggedness (1-5)	4
8	Qty	100
9	Support Years	10
11	Unit Cost	\$ 1,990.19
12	O&S Cost	\$ 398,037.63

Figure 5: Propulsion Electric Motor estimated with Excel

Figure 5 shows the basis of estimate for the Electric Motor is a simple model programmed in Excel and embedded in the TruePlanning estimate. The model was developed just for this estimate and was not to be frequently reused, so it was quickly incorporated through Excel. When the estimate is revisited, the analyst does not need to spend hours looking for the right spreadsheet. The Excel icons next to the parameters indicate that the workbook is stored with the project estimate. It can be easily retrieved and updated at anytime. This feature helps end configuration control problems.

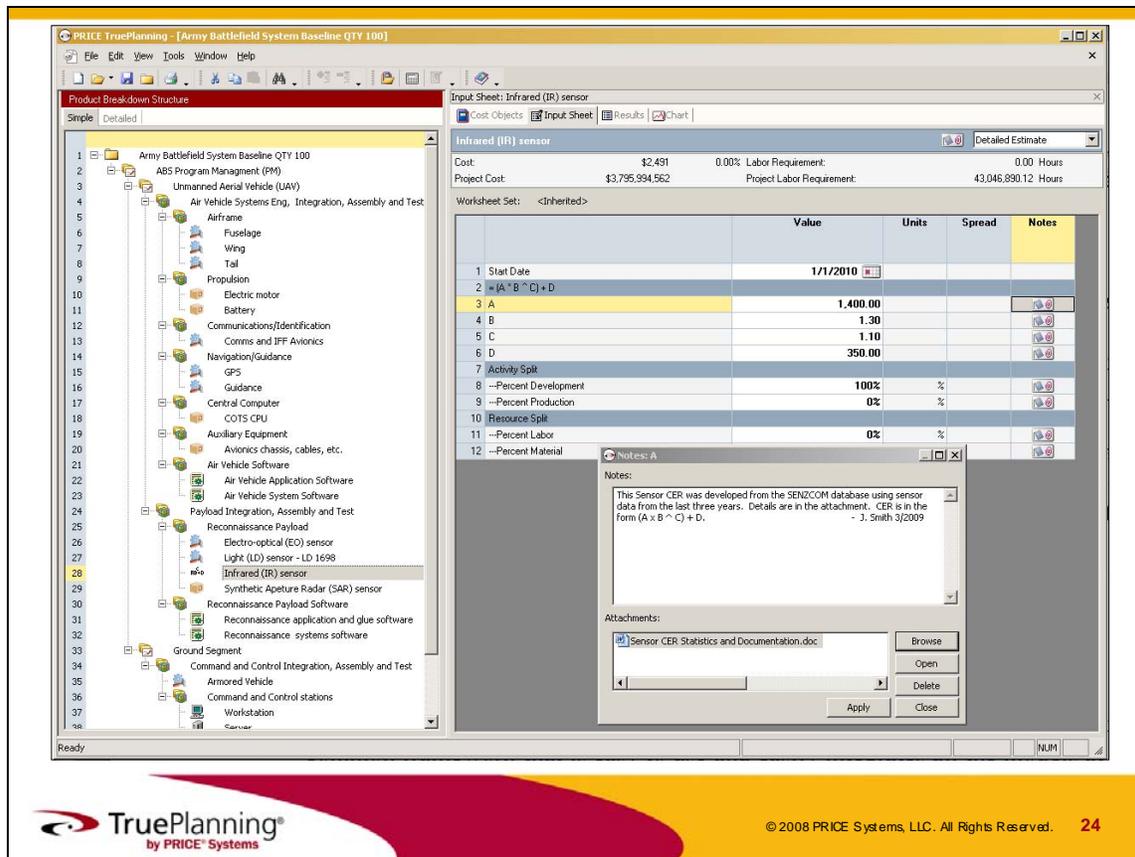


Figure 6: Infrared Sensor estimated with a TruePlanning CER component

In Figure 6, the Reconnaissance Infrared Sensor is estimated with a simple homegrown CER by specifying the parameters in the TruePlanning CER component. The original data and statistics for the CER are documented and stored in the notes and attachment associated with the Sensor item.

### Performance-Based Methodology CER Reflecting Mobility, Lethality & Survivability

- Mobility, Lethality & Survivability Performance-Based CER

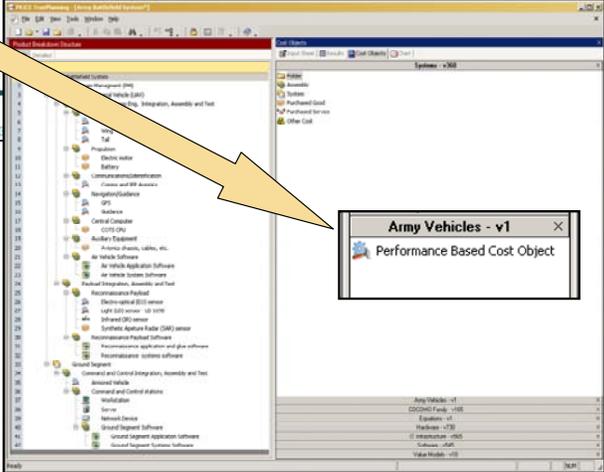
$$UPC\ FY00\$M = -13.627 + [0.019 * Land\ Speed\ (km/hr)] + [0.103 * Water\ Speed\ (km/hr)] - [0.005 * Range\ Land\ (km)] - [0.059 * Personnel] + [0.148 * Survivability\ Metric] + [0.005 * Gun\ Size(mm)] + [3.589 * LN\ (First\ Production\ Year-1900)]$$

R <sup>2</sup> adj	Variable	t Stat
= 0.98	Land Speed	+ 1.7, significant at 88%
= 0.248	Water Speed	+ 11.4
F = 98 (99.9%)	Range Land	- 4.0
n = 16	Personnel	- 4.6
	Survivability	+ 6.8
	Gun Size	+ 2.1, significant at 93%
	Year - 1900	+ 6.5

**Data set includes:**  
**Tanks:** M3A4 Lee, M48 Patton, M60A1, M1 Abrams, M1A2 Abrams  
**Personnel Carriers:** M113A1, AAV7, AAV7A1, Dragon 300 Basic, M1117 (ASV-150), Piranha - Bx  
**Fighting/Recon Vehicles:** A1FV, M2/M3 Bradley, AAV, M551 Sheridan, M114

## Thirty Minutes to Plug-and-Play!







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Figure 7: Any complex model can be easily hosted in TruePlanning

For the Armored Vehicle, the analyst employed a model used frequently by his organization. The model was hosted in TruePlanning by his model-building colleague in just thirty minutes using TrueAnalyst.

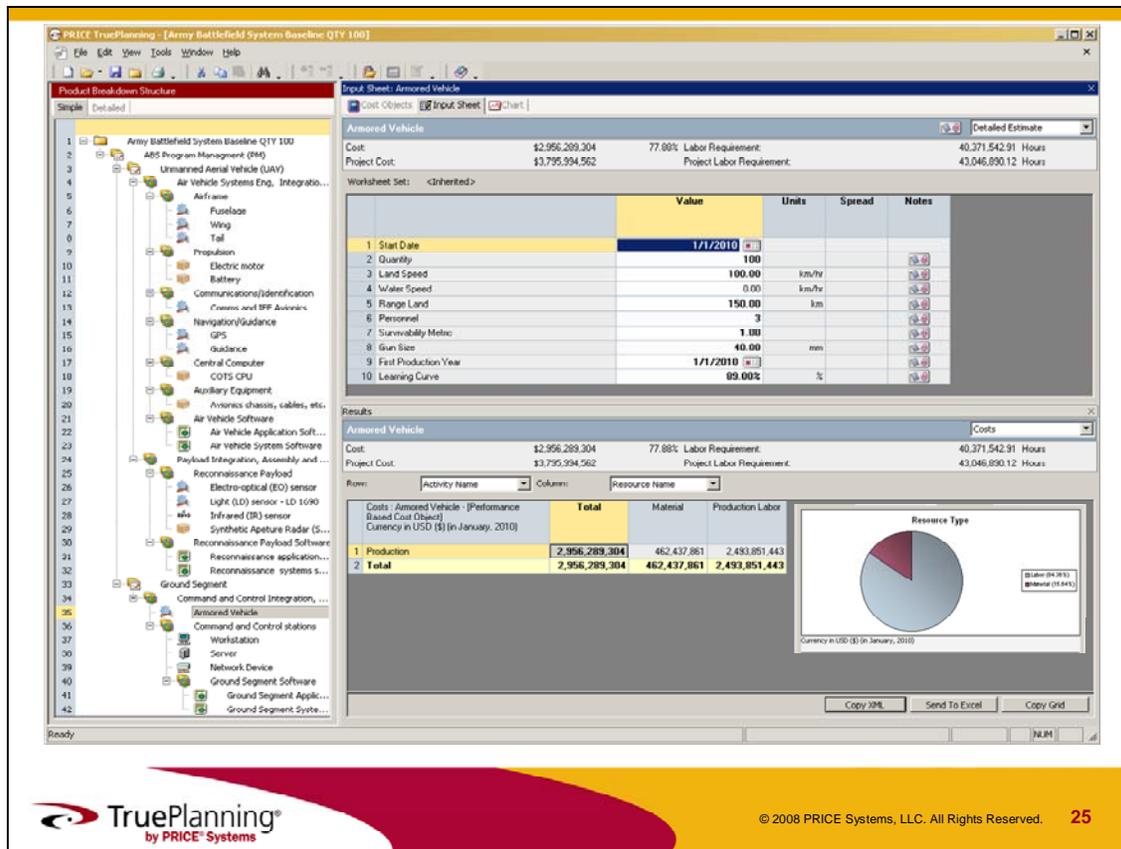


Figure 8: Army Vehicle estimated with Homegrown CER

Once the model is hosted in TruePlanning, it can be dragged from a catalog into the PBS. Figure 8 shows the input sheet, model parameters, and the results for the Armored Vehicle.

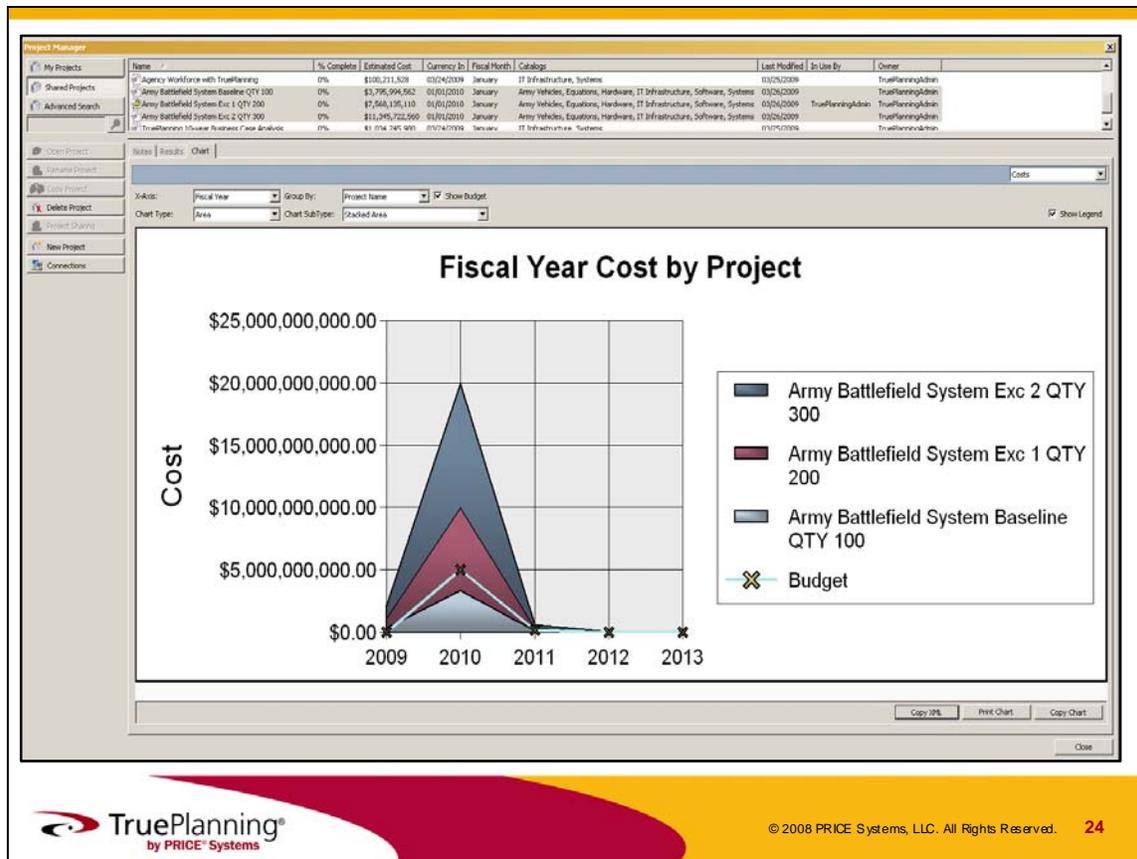


Figure 9: TruePlanning Project Manager shows what scenarios are within budget

After the analyst specified the parameters for each component, an initial estimate was set as the baseline. Of course, management wanted to see several excursions to the baseline. Since all models hosted in TruePlanning plug-and-play together, changes to schedules, quantities and budget constraints are quickly and easily performed.

Management wanted to see estimates for acquisition quantities of 100, 200, and 300 compared to the proposed budget. It was easy for the analyst to estimate the scenarios and store each in the project database. TruePlanning's Project Manager Screen is shown in Figure 9. Management can now select the three scenarios to see how they compare to the proposed budget. The chart in the TruePlanning Project Manager shows that only the 100 quantity scenario is within budget.

**Integrated Framework Benefits**

TruePlanning 2010 addresses the estimating organization problems where no common integrating framework exists. Table 1 details the benefits.

<b>Problem</b>	<b>TruePlanning Benefit</b>
More cost estimating workforce money is spent on spreadsheet programming than on actual CER development	Once a CER is plugged into TruePlanning, no GUI or presentation programming is required to
Usually only one expert knows how to operate the model	PRICE Systems has trained over 11,000 people on our methods. PRICE University is online and available 24/7. The common framework empowers everyone to know how the model works
Models are spreadsheet-based and therefore difficult to distribute and collaborate	TruePlanning is a collaborative, enterprise tool. Once a model is hosted, it is available to all TruePlanning server users.
Models are difficult to link to pricing systems, ERPs and other data sources	TruePlanning uses standard XML-based Web Services to link to other applications on the enterprise.
Maintenance becomes more of a software effort than operations research (managing upgrades, GUI, reports,)	All software maintenance is included in the annual license fees.
Models are not easily audited	The common framework takes responsibility for the calculations where most estimating errors occur, Summations, inflation rate application, cost allocations, resource spreading are all part of the framework. Auditors can focus on the CERs and leave the rest to PRICE Systems V&V and QA.

Table 1: TruePlanning 2010 Implementation Benefits

### Return on Investment for an Integrated Framework

The productivity gains from an integrated framework are evident from the Battlefield System estimate. Quickly coded, plug-and-play models instantly benefit from input screens, parameter validation, output views, and charts. The common data model ensured that changes to quantities, schedules, and other parameters were consistent. Integrating models to excursion analyses empowered analysts to be responsive to management. Reviewers did not need to spend time on the numerous calculations needed to put the estimate together. They focused their due diligence on the CERs.

The business case for an integrated framework was modeled and presented with the new TruePlanning 2009 Business Case Analysis (BCA) features. The BCA assumes an estimating organization with sixty-five analysts (five model builders and sixty estimators) and an annual budget of about ten million dollars.

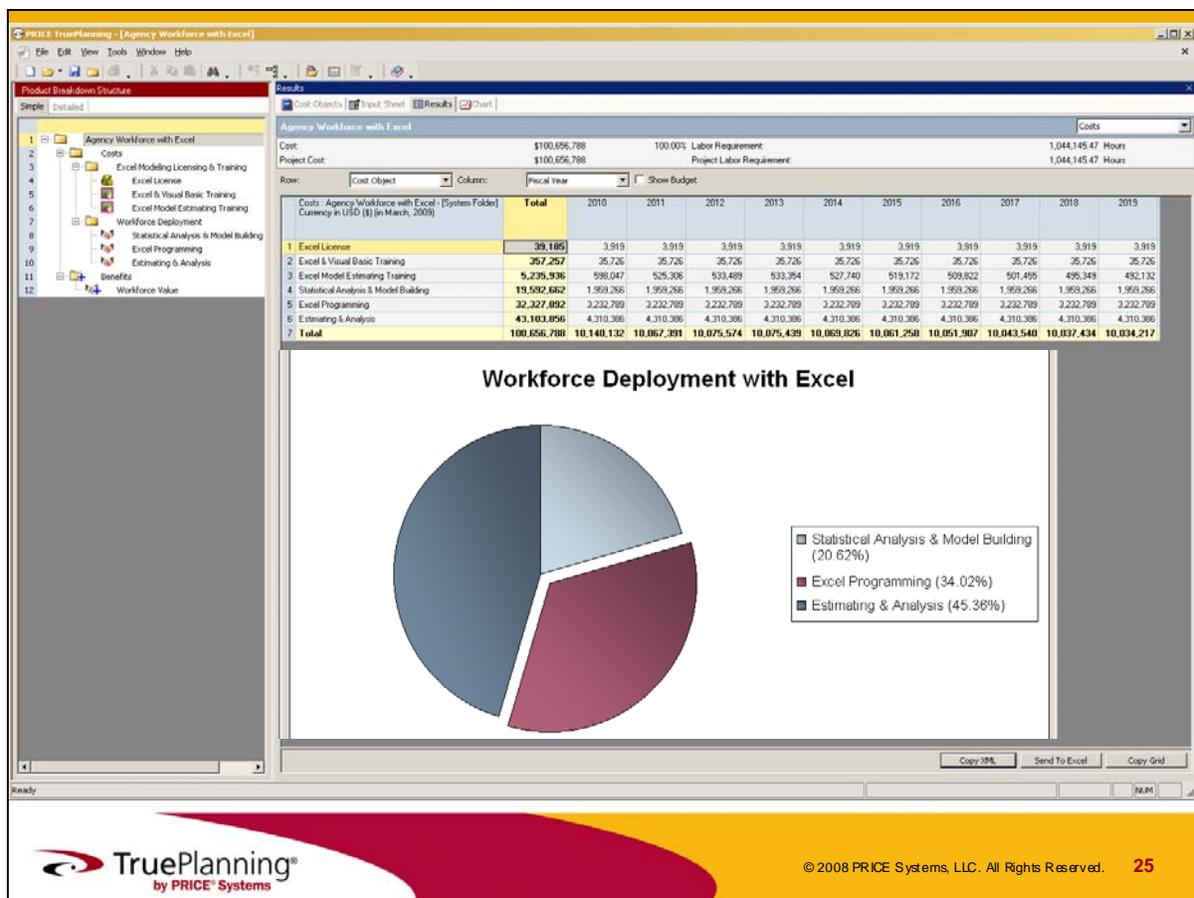


Figure 10: Workforce Deployment for an Estimating Organization with Excel

Figure 10 shows the cost breakdown and typical workforce deployment for an estimating organization with Excel. Over thirty-four percent of the workforce effort is spent programming, manipulating, finding, and recreating Excel workbooks for estimates.

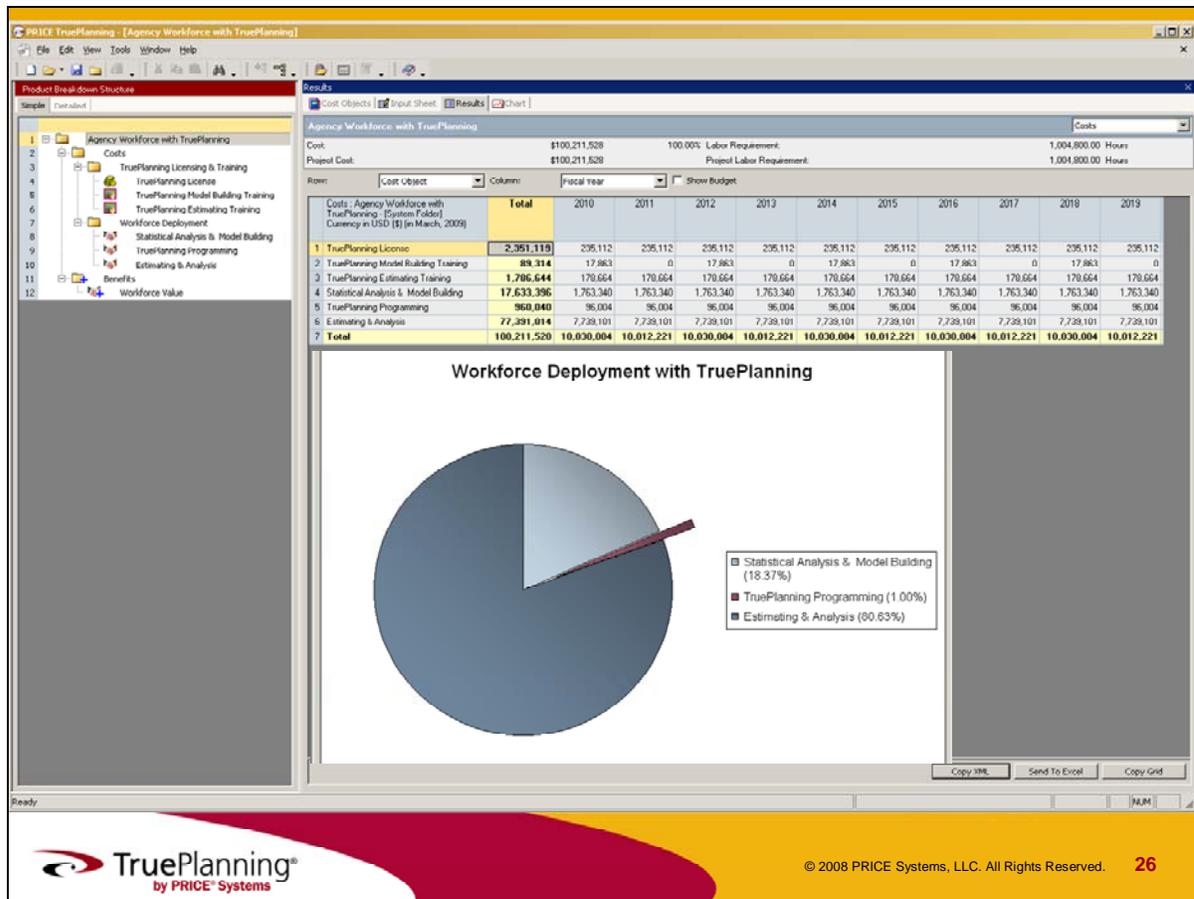


Figure 11: Workforce Deployment for Estimating Organization with TruePlanning

Figure 11 shows the workforce cost breakout for the same ten million dollar annual budget for an estimating organization with TruePlanning. Since homegrown CERS can be quickly and easily hosted in TruePlanning, programming is kept to a minimum, enabling more time for the value-added activities of statistical analysis, model building and estimating.

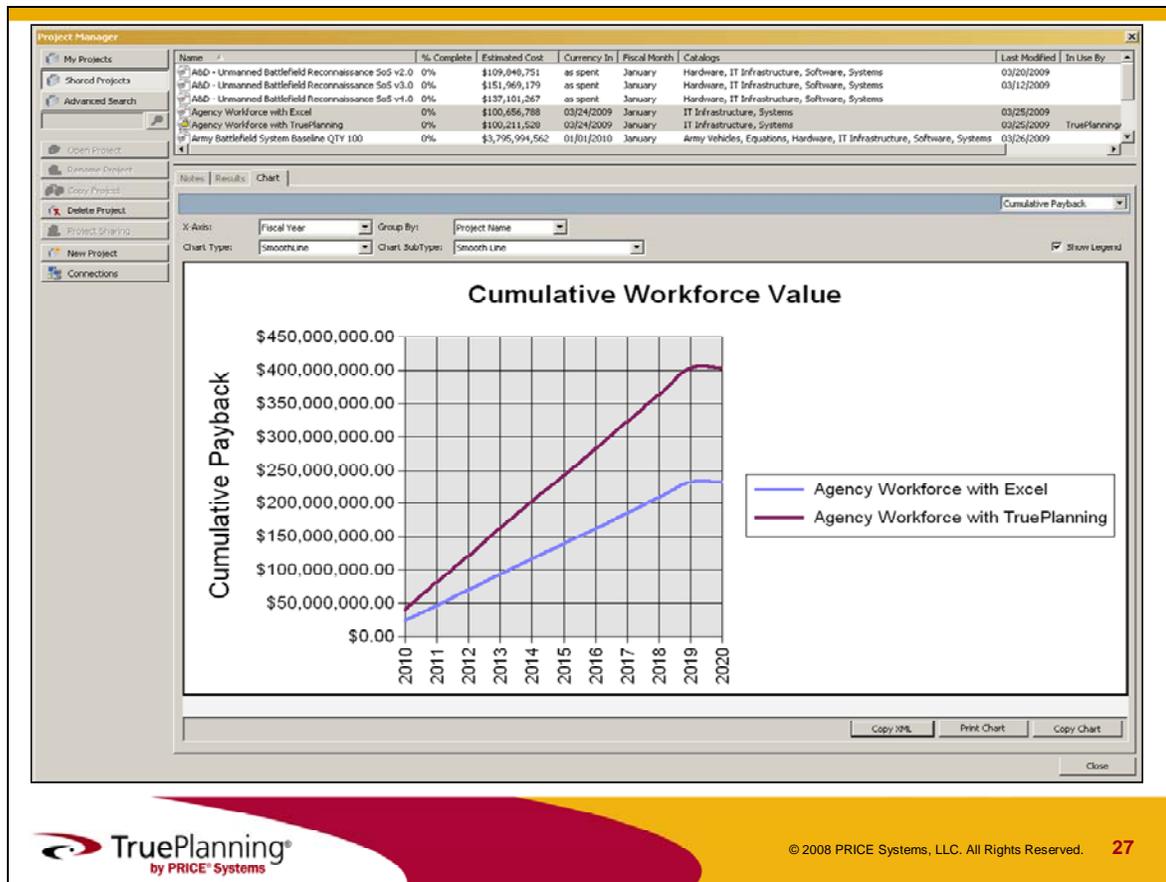


Figure 12: TruePlanning Project Manager View of Two Workforce Scenarios

The BCA value assumption is that three dollars in value is returned for every dollar spent by the agency for value-added activities. This benefit was easily captured with TruePlanning's Value Models. Since the Agency with TruePlanning can spend more time doing statistical analysis, model building and estimating, the benefits outstrip the investment in the first year. Selecting each scenario in the TruePlanning Project Manager View (Figure 12) shows the dramatic difference in value over a ten year period.

### Summary

We can demystify the challenge of a complex estimate by decomposing a system into major subsystems. The best solution to an accurate estimate is to combine every technique in our arsenal: commercial models, public models and homegrown CERS. Most organizations have difficulty hosting, sharing and integrating their CERS with other estimating models. When there is no common framework valuable productivity is lost.

TruePlanning 2010, the latest generation of a long line of estimating solutions from PRICE Systems, integrates estimating models in a common collaborative framework. This paper demonstrated how homegrown cost estimating relationships can be quickly modeled in a standard framework, integrating commercially available models, internal

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systems and data sources. The paper quantifies the return on investment in this approach, emphasizing that the goal for any estimating organization is avoid tool development and to maximize workforce deployment in value-added activities.

The TruePlanning 2010 Alpha release presented is currently being piloted in several locations and is scheduled for release in 2010. TruePlanning optimizes workforce productivity.