“Smart Sourcing”

In the Global Environment

Using SEER Hardware & Manufacturing Tools

Joseph P. Falque
Galorath Incorporated
1382 W. Indigo Drive, Chandler, Arizona 85248
phone: (480) 821-9100, fax: (480) 821-9495
Jpfalque@galorath.com

Abstract

This paper discusses how process-based parametric cost models, SEER-H and SEER-MFG, are used to facilitate proactive real time cost impact assessments of commodity design alternatives in today’s global sourcing environment. The main purpose is to show how model use in the sourcing process can produce a significant financial benefit to any organization that employs the use of the SEER-H and SEER-MFG modeling process. It will also introduce the SEER-H and SEER-MFG estimation cost models, their premise, and flexibility of use in the development of trade study “should be costing” estimates. This approach facilitates organizations to take full advantage of outsourcing cost reductions and profit increases made possible thru the use of parametric cost models. Readers are introduced to how commodity managers and engineers can use these models to obtain substantial cost savings through uses in a ‘real world’ case study.

Introduction

Global sourcing is a procurement strategy aimed at exploiting global efficiencies in production. While a global sourcing process is usually initiated as a mechanism of exploiting cross-geographic arbitrages, simply put, identifying cheaper global sources, it is now a standard step in the global expansion of firms. Global sourcing advantages extend to identifying alternate supplier sources, utilizing buffer capacities and taking advantage of specific geographical talent pools. The process of outsourcing may be considered not only as a type of global sourcing, but of services. Done for many reasons, the primary one is to reduce and control costs, but also to free up internal resources, gain access to world class capabilities, increase revenue potential, reduce time to market, increase process efficiencies, follow company philosophy of outsourcing non core activities and compensate for lack of appropriate skills. See Figure (1) [1] for some of the reasons companies decide to outsource.

Figure (1) [3] “Why Organizations Outsource”

With the rapid growth and expansion of global sourcing, organizations are capitalizing on all of the benefits it provides. Today India and China dominate the global sourcing destinations of most companies, particularly for those based in the United States and Europe. However, near-shore sourcing destinations such as South America and Eastern Europe form significant second-tier markets. It can also be called "near sourcing". See figure (2) “Global Outsourcing Growth”, and Figure (3) “Major Global Outsourcing Recipient Countries”

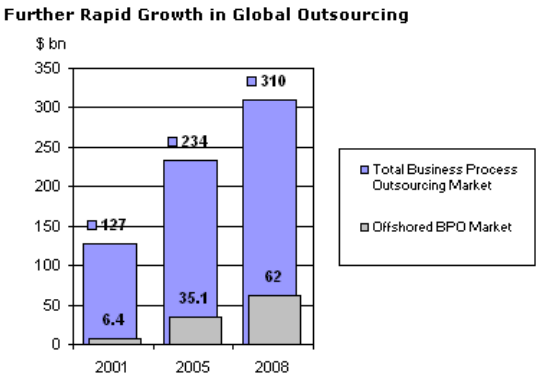

Figure (2) [2] "Global Outsourcing Growth"

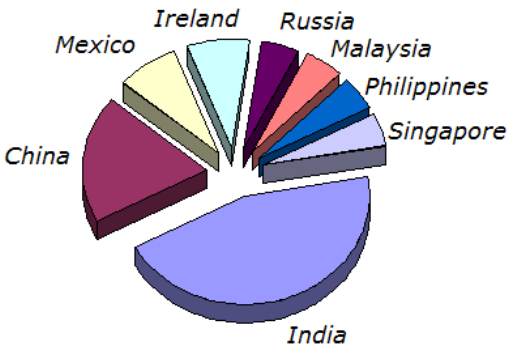

Figure (3), [2] "Major Global Outsourcing Recipient Countries"

International procurement organizations (or IPOs) are essential elements of the global sourcing strategy for any firm. These procurement organizations take primary responsibility for identifying and developing key suppliers across sourcing categories and help satisfy periodic sourcing requirements of the parent organization. Such arrangements help provide focus in country-based sourcing efforts. This is especially true in the case of large and complex countries, such as China, where a range of sub-markets exist and suppliers span the entire value chain of a product/commodity, such IPO's provide essential on-the-ground information. Over time, these IPO's may grow up to be complete procurement organizations in their own right, with fully engaged category experts and quality assurance teams. It is therefore important for firms to clearly define an integration and scale-up plan for the IPO firms. [4][5]

However, organizations have begun to realize the real costs and inherent risks of outsourcing. Instead of simplifying operations, outsourcing often introduces complexity, increased cost and friction into the value chain, requiring more senior management attention and deeper management skills than anticipated. Forced to globalize and meet client demands for closer working relationships, OEMs and vendors alike face significant challenges, including the prospect of diminishing profit margins without a clear understanding of the total cost equation. [3]

Why Do I Need a "Should Cost" Model?

As discussed earlier, we have been experiencing the global outsourcing migration for some time and it is worth a look from a financial perspective to get a feel for the magnitude of the effort as well as the potential value most companies are realizing. The problem simply put is, *what is the right price you should be paying for any given outsourced commodity? What is the total cost of that commodity in real terms?* That's where the parametric cost tools from Galorath Incorporated can help. Organizations have now begun to recognize the real costs and inherent risks of outsourcing. Instead of simplifying operations, outsourcing often introduces complexity, increased cost, and friction into the value chain, requiring more senior management attention and deeper management skills than anticipated. Forced to globalize and meet client demands for closer working relationships, OEM's and vendors alike face significant challenges, including the prospect of diminishing profit margins without a clear understanding of the total cost equation. [6]

The typical business applications involved include accounts payable, accounts receivable, payroll, and expense processing. These are pretty typical applications but the value realized is between 20% and 40%, which represents significant increases in bottom line profitability. These percentages are realized by reduction in overhead costs as well as direct headcount reduction. Expanding this view into the manufacturing arena, the numbers of contracts are increased by 15% to 25%. The primary drivers are the different labor costs and increased resources available in India, China, Brazil, Philippines, and parts of Africa. To understand the magnitude, we can take a look at the number of contracts over the last six years in the Americas, Europe, and Asia for fortune 500 companies, which have more than doubled. See Figure (2). This does not include the contracts awarded by the small to medium sectors which in some cases have seen expediential growth. These contracts have been awarded across all industry sectors including aerospace, aircraft, machinery, automotive and recreational products. The drivers vary but the main factors are labor costs and

availability of resources. The basic trend indicates a rapid growth in global sourcing, as the returns, like the business transaction area, are extremely high and with careful / structured negotiations, profitability is increased significantly. [7] Planning is of paramount importance.

In the manufacturing sector there are multiple views of the global sourcing to consider. One that is a major priority is the commodity management team that basically deals directly with the supply chain and spends significant time in negotiations to obtain the best product price. This is critical, as the impact on profitability can be significant over the life cycle of a program. One focus to consider in this area that appears to provide a good value proposition is to utilize a "should cost" model during the negotiation phase where the commodity manager has information that can be leveraged to obtain the best pricing possible. The following is a top-level description of the process and some quantified data that will illustrate the value potential to the customer. The numbers utilized are estimates and can be modified as necessary to reflect pricing differences based on products, complexity, quantities required per year, etc.

"Should Cost" Effort / Strategy

The primary objective of the estimation effort is to provide the various commodity managers with "should cost" model templates produced in the Galorath Incorporated SEER-H & SEER-MFG models to enhance their supplier negotiations and maximize the profitability (for customer) through the optimization of different critical parameters such as selection of optimum materials, manufacturing processes / operations, set-up and tooling amortization, lot sizes, and automation levels. The SEER models will provide the commodity managers with access to variables that have not been typically available previously. Utilization of the templates will increase the ability to evaluate product pricing from different perspectives, understand the driving pricing criteria and interactively obtain the best price possible.

Debbie Wilson of Gartner may have said it best. "*When price negotiations are conducted with accurate cost models in hand, I firmly believe that they yield superior results. That's because fact-based discussions support joint problem-solving and relationship building with key suppliers far better than just using a heavier hammer or an alternative supplier's hard luck (and consequent willingness to do business at a lower margin) to drive savings. Furthermore, cost modeling provides the basis for continuous cost reduction and waste elimination. It puts RFPs and sourcing projects back in their appropriate place, which is assessing potential suppliers in the marketplace…*"

In this study we will be looking at the problem statement using a jet engine as the example. The first steps are to determine product classes that will be candidates for outsourcing and grouping them appropriately into families or classes of products based upon similarities. Examples such as gears, turbine blades, castings and housings which are machining, castings, forgings, and molded parts could be considered a family unit as well as total commodities like pumps, ducts, starters, and ignition units which are assemblies or complete units that will be inserted into the final end deliverables by the outsourcing company. Utilization of the SEER solution suite can in effect provide two basic but major contributions. For the developer of products and systems, part and assembly affordability are never in doubt. Galorath customers have saved a much as 80% from initial designs to their redefined versions produced using Galorath Incorporated models. On the commodity side where you are buying from suppliers, savings of as much as 25% can be realized and profit margin increases of as much as 50% have been achieved. Taking this approach to create models and a few examples are provided in Figure (5) "Family of Products".

(Customer) Families of Products Top Level View

General Description	Number of supporting Files
Disk, Turbine Engine	18
Shaft Output – Assembly	7
Scroll Assembly, Turbine	41
Wheel Turbine, Axial Flow	18
Pump, Main Fuel	5
Main Control Unit, Digital Electronic	32
Auxiliary Control Unit	12
Inlet Compressor	3
Turbine Assembly	10
Bearing Carrier	5
Torus Assembly, Turbine	12
Housing Assembly	18
Gear Shaft, Helical Output	13
Drive Quill	4
Blade, Turbine Rotor	17
Sub-Total	215 Files
Inter-related files	45 Files
Total	260 files

Figure (5) "Family of Products"

Each family of products normally consists of several files that have some level of inter-related / dependent components such as "make from", multiple configurations from tabulated data, and assembly / sub-assemblies. These conditions increase the number of files involved in the estimation effort to a few hundred

in our example.

Other strategies can be employed such as establishing part/product families tied to key supplier's core competence, strategic alliances and long term contracting or regional supplier classes, etc.

To create the estimates, each product family needs to be examined in detail and various weighting factors can be applied to establish a baseline. The factors include geometric complexity, processes involved such as forging, investment casting, basic machining (milling, lathe, NC machine etc.), welding, bonding, etc., as well as programmatic sizings and quantity adjustments such as production quantity, lot size, set-up and tooling amortization quantities. If available, programmatic data and historical pricing data helps improve the accuracy of the estimates to be developed within the SEER models. It also affords the commodity manager the ability to formulate the best economies of scale from a cost view point, which then they can use to leverage a "Best Price" in the negotiation process weighted by vendor commitment of resources.

It is worth noting that there are several components like the airfoils / turbine blades / impeller that will take longer than members of the disk family where we can apply an approach that is similar to "make from with exceptions". Using the differences in complexity and similarities, we were able to establish a standard per component estimate which is provided in Figure (6) "Should Be" Model Creation Effort.

"Should Be Model Creation Effort"	
Product Families 1 through 15	3 hours each / TBD
Number of individual component and associated Files	260 / TBD
Total Effort (Estimation)	780 Hours / TBD
Charge Per Hour	$150
Total Estimate	$117,000

Figure (6) "Should Be Model Creation Effort"

There are a couple of critical factors to consider with the above that need to be considered regarding the estimate. The total effort is a little more than one-third of a man-year to complete all the estimates. From an economic perspective the effort is approximately 50% of a fully single burdened cost of a (Customer) employee. The issue we are dealing with is time compression to generate the models that will be used in supplier negotiations. The compression is dependent on the individual learning curve, dual discipline experience (application / economics), and knowledge of the estimation model.

The sequence of the modeling will be determined by the supplier negotiations schedule to maximize the return potential, i.e.; bottom line profitability. Additionally, Galorath Incorporated has used a technology transfer strategy during the modeling effort that will compress the (Customer) Commodity Management learning curve and enhance their ability to negotiate contracts with maximum cost reductions that can be measured in bottom line profitability.

To provide an example of the potential profitability, the following value proposition provides a parametric range of benefits that a customer can expect to receive. To determine a cost baseline, a few assumptions have been made to create the costs for the different families. To start, the total number of products has been sub-divided, an estimate for each section has been applied, and a quantity per year is also assumed. If desired, these numbers can be projected over the life cycle of the products to get a feeling of the total costs involved. Figure (7) "Family of Products / Current Cost Estimates" gives us an approximate view of the current costs and sets a range for potential ROI.

Family of Products / Current Cost Estimates				
Partition Breakdown	File / Components	Estimated / Per Unit Cost	Quantity Per Year	Estimated Costs Per year
Part Family I	65 Units	$1,750	350	$612,500
Part Family II	65 Units	$2,500	450	$1,125,000
Part Family III	65 Units	$3,500	575	$2,012,500
Part Family IV	65 Units	$4,500	1,200	$5,400,000
Estimated Total	260 Units	$12,250	2,575	$9,150,000

Figure (7) "Family of Products Current Cost Estimates"

Please note, as stated previously, the numbers are estimates only and any differences from the actual historical data can be incorporated to improve the accuracy of the data. Using this data we will consider a parametric cost improvement using the models to establish a new cost baseline going forward to get a view of the potential range of saving. We use a 10% and 30% improvement and apply a probability factor to cover risk and uncertainty. This information is presented in Figures (8) "Family of Products Current

Costs with a 10% Improvement" and Figure (9) "Family of Products Current Costs with a 30% Improvement" respectively.

Family of Products / Current Cost Model Estimates @ 10% Improvement				
Partition Breakdown	**File / Components**	**Estimated / Per Unit Cost**	**Partition Quantity Per Year**	**Estimated Costs**
Part Family I	**65 Units**	**$1,575**	**350**	**$551,250**
Part Family II	**65 Units**	**$2,250**	**450**	**$1,012,500**
Part Family IIII	**65 Units**	**$3,150**	**575**	**$1,811,250**
Part Family IV	**65 Units**	**$4,050**	**1200**	**$4,860,000**
Estimated Total	**260 Units**	**$11,025**	**2,575**	**$8,235,000**

Figure (8) "Family of Products Current Costs with a 10% Improvement"

Family of Products / Current Cost Model Estimates @ 30% Improvement				
Partitioning Breakdown	**File / Components**	**Estimated / Per Unit Cost**	**Partition Quantity Per Year**	**Estimated Costs**
Part Family I	**65 Units**	**$1,225**	**350**	**$428,750**
Part Family II	**65 Units**	**$1,750**	**450**	**$787,500**
Part Family III	**65 Units**	**$2,450**	**575**	**$1,408,750**
Part Family IV	**65 Units**	**$3,150**	**1200**	**$3,780,000**
Estimated Total	**260 Units**	**$8,575**	**2,575**	**$6,405,000**

Figure (9) "Family of Products Current Costs with a 30% Improvement"

It should be noted that these numbers are conservative and higher savings should be realized leveraging the model information. In any case, to account for any differences between the estimated improvements and the historical cost data we will apply a .50 probability factor.

The resulting savings that can be expected is $457,500 and $1,372,500 respectively. This does not include other ancillary factors like negotiation standardization, variable optimization, lot size allocations, actual material pricing, supplier capabilities and other considerations included in the model that will enhance the returns.

As you can see in Figures (7) and (8) which provides a positive view of the effort proposed and it is probably worth taking a quick look at a cost / benefit analysis to get the ratio between the projected benefits and expenses using cash inflows versus costs.

The benefit numbers are based on the low savings using the 10% savings estimate.

Cost / Benefit Model				
Year (t)	**Estimate Development Expense**	**Model Procurement**	**Benefit**	**Net Benefit**
Year 0	($117,000)	($30,000)	$0	($147,000)
Year 1	($117,000)	($30,000)	$457,500	$310,500
Year 2	($117,000)	($30,000)	$457,500	$310,500
Year 3	($117,000)	($30,000)	$457,500	$310,500
Total	($468,000)	($120,000)	$1,372,500	$784,500

Figure (10) "Cost/Benefit Model Using 10% Saving"

Using the data in Figure (10) the return percentage is approximately 300%. This should be taken as a reference only as it only covers a four-year window and it is based on the low estimate for returns. More importantly, it does not include an accounting for all the annual operational expenses, thus making changes to the model to account for configuration changes (ECO's) in the product family etc. This also does not include any benefits in the first year which is contrary to what customers have experienced as there are documented cases where organizations have hit the ground running using the Galorath Incorporated models in negotiations realizing immediate payback. The models should and will help reduce outsourcing costs within the first two to three months.

Using the four year example you can see the benefits, but if one were to extend this for a product or program life cycle you can see the greater benefits. A twenty (20) year program life cycle is the norm in the case of our engine premise. Using a twenty (20) year case holding all of the other parameters constant, the cash inflows are significant and the profitability to (Customer) is very high. A conservative view is in the range of several millions of dollars. As I have stated, some of these numbers are estimates, as I am prohibited to use the actual data but is very reflective of reality.

The model in Figure (11) will incorporate the time value of money where the marginal value for (Customer) is 15%. All other numbers will remain constant for our example.

Cost / Benefit Model NPV				
Year (time)	**Estimate Development Expense**	**Model**	**Benefit**	**NPV Benefit**
Year 0	($117,000)	($30,000)	$0	($147,000)

Year 1	($117,000)	($30,000)	$457,500	$269,925
Year 2	($117,000)	($30,000)	$457,500	$235,226
Year 3	($117,000)	($30,000)	$457,500	$204,276
Total	($468,000)	($120,000)	$1,372,500	$562,427

Figure (11) "Cost/Benefit Model NPV"

As you can see, the expenses are treated as occurring at the beginning of year 1. It is clear that the investment is equivalent to a gain over the period of four years. Again the approach is very conservative and the actual yields will be significantly higher. It should be noted that any percentage in the marginal value of money will reduce the total gain but not enough to make the final total gain a negative number.

Using the above numbers the approximate payback period is provided below for reference in Figure (12) NPV Payback. What this illustrates is that there is no risk associated with the estimation effort and the profitability picture is increased significantly starting in year 1. Again, this assumes no benefits will be received in the first year which is not reflective of our real-world experiences.

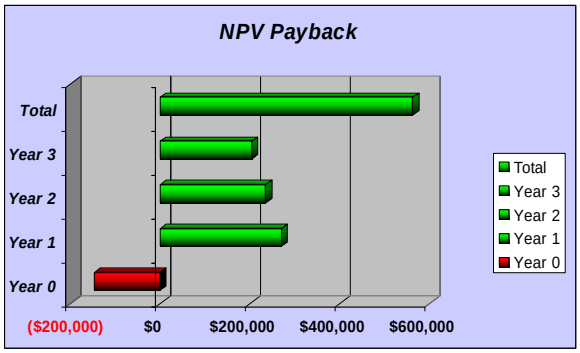

Figure (12) "NPV Payback"

The Commodity Manager – "Should Cost" Strategy

Let's take a look at a couple of the major benefits associated with the "should cost" modeling and supplier negotiation process. To begin, we have access to the many variables not normally available, such as process optimization, i.e., the cost variance between castings and forgings, bar stock machining and castings, adjustments in tight tolerances, and selection of various materials. We also have the ability to rate the manufacturer from a capability standpoint, which may include things like machinery automation levels, condition and types, the skills of staff, and experience with the specific type of work in question. We also have the option to make trade studies for programmatic data like set up amortization, lot size modifications etc.

So far we have taken a look at the "should cost" modeling where the different components have been modeled using the SEER models and made available to the commodity managers for negotiations with the suppliers. To make sure the commodity management team knows how to adjust parameters and evaluate the different prices, a technology transfer session will have to occur so there is a clear understanding of the SEER models, what is required to make parameter adjustments and perform trade studies that will provide an immediate view of the pricing changes. The approach to the modeling as we have discussed above is to utilize the SEER model team to create the models as this compresses the overall cycle time to complete the models and help to ensure accuracy in the final product. However many organizations have and will engage their own individual manufacturing experts to complete these tasks.

Training in the use of the SEER models will have to be utilized on two different levels. First, for the developers of the commodity family or class templates, an in-depth training curriculum is required. Next, the commodity managers will require an overview and familiarization course in the SEER model environment.

This is followed with technology transfer sessions where we leverage the product models and illustrate the process of optimizing the pricing with the adjustments of the different parameters in the model. This can include order size, tooling and set up amortization, material selection, geometric tolerances of the component in question, processes involved such as machining from raw stock versus castings, supplier capabilities, buy quantity / lot sizes, and numerical control / manual machine tools. The main point is this approach is designed to bring commodity managers up to speed using an existing model in the negotiation process in a compressed time frame.

Galorath Incorporated and the SEER Enterprise Suite of Tools

SEER-H

SEER for Hardware, Electronics & Systems is a project estimating software model that supports planning efforts throughout the project development lifecycle from project inception to production, including systems level support, product development, production, operational and support and disposal costs. The planning aspects of SEER-H provide detailed insight into the risks; uncertainty and cost drivers associated with hardware, electronics and systems development, acquisition and integration. SEER-H enables project engineers, planners, and managers to determine

lifecycle costs and development timetables for hardware projects spanning: Mechanical, Electronic, Structural, and Hydraulic aspects.

Unlike CAD and EDA tools which focus on designing features and functions, SEER-H focuses on providing an early preview of the effort, cost, time-to-market, staffing, risk and reliability involved in bringing a product to market and maintaining it over time -- a powerful adjunct to traditional project management software applications. Estimates are inclusive of development, production, operations, and support, addressing what is being built (the component, sub-system, system or system of systems), how it must perform, and how and where it will be built. For system-level estimates, SEER-H explicitly addresses the added costs associated with integrating components and subsystems into a coherent, functioning system. All SEER solutions are built on the same design principles, incorporating the following application elements:

SEER-H Interface:
It is an intuitive interface for defining and describing projects. Users can generate a new project from an existing project "template" or by adding and defining individual work elements. It has a series of pop-up windows and annotations guide users through the process of defining project scope, complexity, and technologies. Shown in Figure (13)

Simulation/Modeling Engine:
Sophisticated sector-specific mathematical models derived from extensive project histories, behavioral models, and metrics.

SEER-H Built-in Knowledge Bases:
SEER Knowledge Bases serve as a virtual "in-house expert," providing default project definitions, values, ranges, and calibrations based on comparable project histories. The model enables users to develop first-look estimates when very little information is known, and to refine those estimates as details become available.

SEER-H Outputs:
A variety of charts, graphs, and reports for quickly summarizing and presenting project outcomes and alternatives as well as work-in-progress are provided, including an open architecture and APIs that ensure SEER applications can be easily integrated with departmental productivity solutions and enterprise applications.

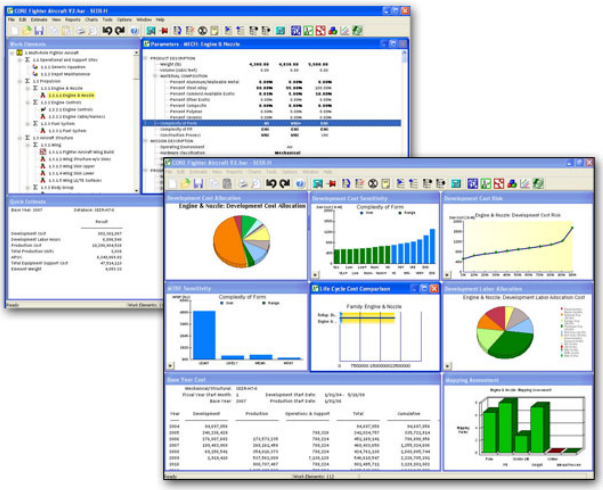

Figure (13) "SEER-H User Interface"

SEER–MFG

SEER for Manufacturing is project management software tool with core capabilities to plan, manage, and control manufacturing projects and processes. The best design in the world is destined to fail if it can't be efficiently and reliably manufactured. Where SEER for Hardware evaluates and analyzes product options, SEER for Manufacturing (SEER-MFG) focuses on manufacturing project and process options, and can be used to model virtually any manufacturing operation. SEER-MFG project estimation software is a key component of a complete design for manufacturability program. It enables organizations to optimize both functional design and costs for production, providing a realistic and manageable view of production costs, labor, materials, tooling, set-up and rework. SEER-MFG is a key component of any Design to Cost solution, and SEER-MFG is widely used by manufacturing outsourcers to develop "should-cost" guidelines, and by manufacturing subcontractors who need to reduce bid preparation time and error rates, and to quickly determine when not bidding at all is the best

option. SEER-MFG has a broad set of manufacturing processes supported, including company-defined processes as shown in Figure (14)

Figure (14) "SEER-MFG Manufacturing processes"

SEER-MFG Interface:

The model has an intuitive interface for defining and describing projects. Users can generate a new project from an existing project "template" or by adding and defining individual work elements. It has a series of pop-up windows and annotations guide users through the process of defining project scope, complexity, and technologies.

SEER-MFG Simulation/Modeling Engine:

Sophisticated sector-specific mathematical models derived from extensive project histories, behavioral models, and metrics.

SEER-MFG Knowledge Bases:

SEER Knowledge Bases serve as a virtual "in-house expert," providing default project definitions, values, ranges, and calibrations based on time and motion studies. The model enables users to develop first-look estimates when very little information is known, and to refine those estimates as details become available.

SEER-MFG Output:

The model has a variety of built-in charts, graphs, and reports for quickly summarizing and presenting project outcomes and alternatives as well as work-in-progress.

Open architecture and APIs ensure that SEER applications can be easily integrated with departmental productivity solutions and enterprise applications.

SEER-MFG is designed to enable both intermittent and advanced users in management, finance, engineering, industrial design, and manufacturing to evaluate process options and tradeoffs impacting such factors as ease of fabrication and assembly, number and availability of parts, materials selection, and failure and repair rates. As with all SEER project estimating software solutions, users can optimize their process strategy by performing extensive trade-off analyses – varying assumptions and options to determine what manufacturing strategy is likely to produce the best outcome. The results of these analyses can be documented and shared using SEER's rich reporting capabilities, as well as exported to numerous 3rd-party applications. Enabling organizations to model a broad range of manufacturing processes, SEER for Manufacturing provides a strong adjunct to traditional project estimating software, cost estimating software, and workflow software solutions. As seen in Figure (15) SEER-MFG User Interface.

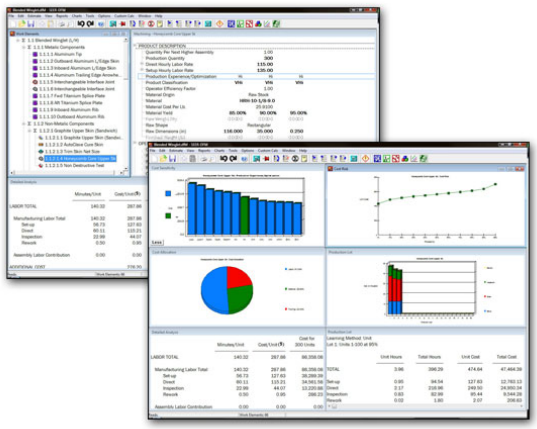

Figure (15) "SEER-MFG User Interface"

For further information and/or to obtain an introduction and insights into the Galorath Incorporated family of estimation tools you can visit the Galorath Incorporated website at http://www.galorath.com/ .

Epilogue:

"Some Food for Thought"

"A Supplier Modeling Strategy"

(A different viewpoint)

There is another view of the outsourcing process that adds even more value to the customer and increases the profitability factor. Boeing and the 777 program introduced the strategy in the manufacturing sector a few years ago that proved very beneficial. Basically they shifted responsibility to the manufacturers for access to design information reducing the internal requirement for a configuration management team, which is expensive. If you wanted to participate in the 777 manufacturing opportunities you had to have a Catia workstation and receive the detail design files electronically. If you did not have this capability you did not have the opportunity to submit bids. Following this logic the same holds true for the "should cost" model.

Why should the OEM or Prime contractor own the model development process and then negotiate with the supplier? The supplier should be the one to create the model and explain the various parameter selections used including a justification for the selections. What this does as noted above is shift the responsibility to the source of the processes and reduces the internal requirements for trained personnel, model configuration management, and should help reduce the direct headcount for a given program.

References

[1] Overby, S (2007) ABC: An Introduction to Outsourcing. CIO.com.

[2] Norwood et al (2006) Off-Shoring: An Elusive Phenomenon. National Academy of Public Administration

[3] Computerworld and InterUnity Group Inc., Concord Mass., April and May 2003.

[4] Rothman, J. (2003), 11 Steps to Successful Outsourcing. www.computerworld.com

[5] Engardio, P. & Arndt, M. & Foust, D. (2006) The Future Of Outsourcing Business Week

[6] Brad Vaughan, Ken Buchanan, & Richard Evans,

Manageability Services Practice White Paper September 2005, A SMART SOURCING IMPLEMENTATION R0ADMAP

[7] Fisher Center for Real Estate & Urban Economics

(University of California, Berkeley) Year 2003 Paper 1103 Fisher Center Research Reports, The New Wave of Outsourcing Ashok D. Bardhan, Cynthia Kroll†