P^3S: The Parametric Proposal Pricing System
"The Virtual Bidding Machine"

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Abstract

The concept of P^3S: The Parametric Proposal Pricing System is approaching maturity. It bears little, if any resemblance to the massive, often sluggish system it replaces. P^3S is a multi-functional, dynamic business process created by the convergence of several initiatives: Parametrics as the basis of estimating; Proliferation of desk-top computing; Client oriented information system interfaces; Re-engineered business practices; and Evolution of parametric estimating methods. This document examines changes in business culture caused by the initiatives, and exemplifies how change can be put to work in building a responsive and credible system. Among the topics discussed are:

- The criteria for an acceptable parametric based estimate.
- The power shield erosion caused by desk top computing.
- The need to integrate technical/process/business information and functions.
- The continuous drive of computing technology to, "catch-up to humans."
- Working in today's empowered, adaptive business environment.
- Adding more value in less time.
- Taking exactly what is needed from a parametric model.
- Building and using information interfaces to inter-connect the virtual bidding machine.

Introduction

Parametric Proposal Pricing System (P^3S) - The Virtual Bidding Machine. It sounds like another trendy phrase for a blue skied dream that will never materialize. Don't be mislead by the title - this is more than a concept whose time has come; this is a working process in use now. Today's implementation is not as seamless as that of the future; nevertheless, even with a less than ideal infrastructure, staggering improvements in efficiency are being realized now. We are talking about a new order to the process of bidding for work, which is what every vital business enterprise does on a recurring basis. Presently, the order relies on skilled parametric estimating clients, calibrated estimation tools, realistic new project attribute forecasts, and flexible pricing programs. In the future, integrated environments for product development, project management, and process control will increase the domain of P^3S clients within an enterprise. And, implementation will be accomplished with a short and enjoyable learning process for the new breed of client.

The realization of P^3S is subtle. It is happening more as the result of colliding business initiatives and trends than as a conscious path of technological pursuit. The merging trends originate in different functional areas of a business, making the practice of parametric proposal pricing truly cross functional. This P^3S bidding process defies comparison to the traditional sequential bidding process it is replacing. Never before have technical and business operations professionals worked so closely together for so long in a product life cycle. In the old system, the product life cycle is like a ladder

climb, where tasks are handed off from one function to the next for upward progression to the eventual goal. A specific function (like quality assurance, for example) usually concentrates on climbing just a few rungs of the ladder, before and after which that function's active participation in a product's success is limited. In the new system, the business apparatus used to guide a product to success is more like a web, where the goal is centric to the functions that weave the web. The resources (people and tools) used to evolve a product reside on the web, enabling their involvement to be continuous over the product life cycle, as well as linking them together. When someone moves on the web, it sends an immediate stimulus to everyone else on it. The web characterizes a structure that is dynamic (it continually grows from a central core), responsive (it ripples when struck), and integral to the business it serves (it sustains its residents). These are the very features that are propelling P^3S use.

Converging Initiatives

The post World War II business model of an organizational hierarchy producing goods and services in a well defined, sequential process began to crumble in the late 1980s. The effect is change. This change is inescapable for most everyone producing goods and services today, and it is often painful to individuals. It is not a matter of *if*, but *when* change will affect your business life. Change is a series of actions, and all actions require initiation. There are at least five business change initiatives that are meeting to enable realization of parametric proposal pricing systems:

1. Use of Parametrics as a Basis of Estimate (BOE).
2. Proliferation of Desk-Top Computing.
3. Improved Client Oriented Interfaces.
4. Overhaul of Business Practices.
5. Evolving Parametric Estimating Methods.

Parametrics as a Basis of Estimate (BOE)

A panel was convened at the 1993 Society of Cost Estimating and Analysis (SCEA) conference in Phoenix, AZ to address the issue of acceptance of parametric estimating in bidding to the US Department of Defense. The panel was composed of subject matter experts from industry and government auditing. Their objective was somewhat more aggressive than that of many panels - it was to force the issue of parametrics acceptance to the breaking point. If parametric estimating is worthwhile, it would withstand close scrutiny and criticism to mature into a significantly larger contributor to business conduct. If not, it would perish.

Arguably, that panel was the catalyst to what has become a formally sanctioned US government reinvention laboratory project, known as the Parametric Cost Estimating Initiative, or PEI. The PEI was formed in 1994 as an industry and government working group project to identify and remove barriers to use of parametric estimating systems in bidding. A pilot program is underway, where over 10 industry organizations have agreed to audits of their parametric systems and to use of the systems as the basis of an actual bid. The pilot program was started in 1995, and is scheduled to run through 1996. As the PEI gains recognition, it also gains participants, many of whom are unfamiliar with parametric estimating. This has caused realization of a barrier identified by the PEI steering committee in 1994 - education. Education about parametrics is recognized as the number one challenge currently facing the PEI. In response, educational programs have

been established within training institutes of the US Department of Defense. At the moment, these programs are meeting the introductory needs of new PEI participants, but more in-depth programs will be needed in the future.

Support for PEI is strong, as indicated by the following quote from a 1995 letter to the military services and defense agencies from Ms. Eleanor Spector, Director of Defense Procurement within the US DoD.

> *"I fully support the use of properly calibrated and validated parametric cost estimating techniques on proposals submitted to DOD, and I encourage your enthusiastic support."*
>
> *"Properly calibrated parametric techniques can accurately estimate costs while reducing bid and proposal costs and proposal cycle time, and expediting the government evaluation process."*
>
> Eleanor Spector, Under Secretary of Defense, 1995

Calibration is a key qualifier of Ms. Spector's parametric endorsement. A calibrated estimating system is one that has been molded to the experience of the organization that uses it, just as a driver adjusts the seat and steering wheel of his or her automobile to individual driving experience. Calibration looms large in the acceptance criteria established by the Defense Contract Audit Agency (DCAA), listed below.

Criterion	Importance
Verifiable Data	*Demonstrates the pertinence of the calibration data to the estimating relationships.*
Easy to Monitor	*Demonstrates vitality of estimating relationships through continuous evaluation.*
Logical Relationship	*Demonstrates the highest degree of correlation of the cost-to-noncost parameters.*
Estimate Support	*Demonstrates vitality of estimating system through constant use and maintenance.*
Fairly Accurate Prediction	*Demonstrates acceptable test results with data like that of the calibration .*
Significant Statistical Relationship	*Demonstrates a high degree of confidence when using sound data for input.*

Though written specifically to address the subject of acceptable parametric estimating techniques, the acceptance criteria above represent common sense conditions surrounding any credible estimating process - parametric or otherwise.

How should a good parametric based estimating system be established? Good, in this context, means a system that is likely to satisfy the DCAA criteria. All of the examples in this writer's experience share one common characteristic: a good system is built, rather than bought. Certainly a commercial parametric tool, like PRICE, may be part of the system. But, without education and care, it cannot help realize its full potential. The good parametric estimating systems of our time evolve in a five step process.

5 Step Implementation to Credible Parametric Estimating

1. *Survey Available Data Sets.*
2. *Extract Information From Surveyed Sets.*

3. *Construct Parametric Database With Extracted Information.*
4. *Calibrate Parametric Tool(s) to Database.*
5. *Use, Monitor, and Maintain System.*

Notice the relationship between the audit criteria and the process steps recommended above. These steps are intended to minimize the creation of new things - be they data items or techniques. We have seen all too often how new processes tend to take on a life of their own by distracting system implementers away from the original goal (improving estimating) to tool or process glorification. This is a dangerous trap that can be avoided if existing tools and data are coupled with new thinking. The good systems are examples of this truth.

Desk Top Computing

Ten years ago, an analyst or engineer was fortunate to have a dedicated personal computer at his or her disposal. Today's engineers may have more than one devoted to them alone, and probably have a computer or two in the home for family use. There is no argument that the computer age is here and that it impacts the lives of every working person. In 1994, the PC outsold the television as the number one consumer entertainment appliance purchased in the USA. In a recent poll of PC owners, 58% said that they planned to reduce television time in order to spend more time working on the computer. No doubt that much of this work will be devoted to more than game playing; it will involve information retrieval, education, transaction processing, and business pursuits with expected revenue generation consequences. More than 3 trillion dollars worth of electronic fund transfers take place every day - this is almost one-half of the annual US Gross Domestic Product in one day! Most, if not all of these transactions begin at a desk or work station. The power to quickly transact business resides on the top of any desk holding a personal computer. It is no longer necessary to physically travel to a central location in order to conduct business or attend a seminar with other people. Now, the information travels to the individual through a network connection as small as a telephone jack. Networking has practically brought the world to the computer screen.

The pace of computing technology advancement is at once awesome and frightening. Ten years ago, who could have imagined what we have today? The pace has left more than a few people nervous that they are watching the train go by, rather than riding as passengers on it. Fortunately for those of us using the technology, there are others studying it's practical interaction with humans. One particular scholar is Roger Shank, currently head of a computer learning laboratory at Northwestern University. In 1984, Dr. Shank, while occupying a similar position at Yale University, published the book, *The Cognitive Computer,* in which he offered the following glimpse of what computing required to become more universally adopted:

> *..There won't be a good market for such home systems until people can hook up their personal computers to the large computer timesharing networks…In 10 to 15 year's time, such networks may indeed spring up, in which case there will be a flurry of activity to create learning systems for stockbrokers, doctors, librarians, and business management..."*
>
> Roger C. Shank, *The Cognitive Computer,* 1984

In this, the early days of the Internet, that 1984 prediction is remarkably prophetic. Later in this paper we will revisit Dr. Shank for some reassurance that we haven't missed the train to computing paradise.

Client Oriented Interfaces

Making computers easy to use may be more important to technology merchants than making more powerful processing machines. Ironically, it is often the improvements in power that enable easier use, making both advances necessary ingredients of a recipe for market success. The automobile illustrates a familiar example. To operate an automobile in the early years of that product, the driver needed to be part mechanic and part engineer. Starting involved turning a crank; fuel/air mixture was controlled with a manual choke; shifting was manual; and so on. Today's version of the automobile usually requires only the ability to turn a key and move a lever. The automobile of today is easier to use, and so, more are used. The same evolution in ease of use can be found in refrigerators and ovens (frost free, self cleaning, etc.), televisions (channel scan, auto tune, etc.), and the computer. Graphic User Interfaces (GUIs) and natural language understanding are but two examples of initiatives designed to make the computer reach into the lives of more people. Development of these and every other feature that orients computer interfacing more to a client's natural language widens the embrace of computer technology.

Once again, we can refer to the 1984 work of Roger Shank in predicting the client oriented interface movements of today:

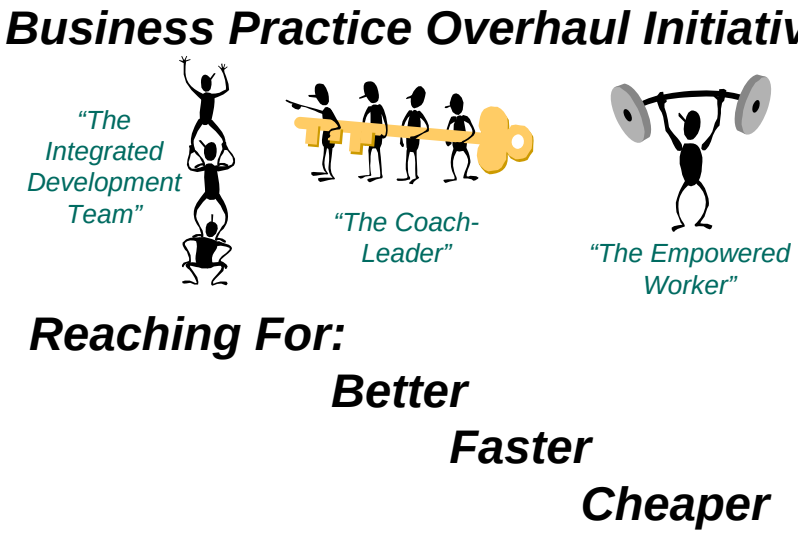
> *"…Stop worrying. The computer revolution has not passed you by. In fact, quite the opposite is the case. The computer revolution hasn't caught up to where you are. If you can't use today's computers without pain, then just wait. It is the computers that will change, not you..."*
> Roger C. Shank, *The Cognitive Computer,* 1984

While many of us feel unprecedented change in our day-to-day business lives due to computers, it is strange to allow that the greatest changes are in technology adapting to humans, rather than the other way around.

Business Practice Overhaul

A business overhaul trend that began in the late 1980s, roughly at the end of the Reagan administration, has marked the Sequentially Processed/Organizational Hierarchy paradigm for retirement. Things have changed. The market place, once local or national, is now global. Competitors are fewer and, because they have survived, much stronger. Boundaries of geography, culture, and enterprise are less restrictive. The quest for investment capital has created an almost insatiable appetite for profit. This quest has an associated slogan used throughout industry today: Better, Faster, Cheaper; as in higher quality goods and services, delivered more expeditiously, at lower cost. To be sure, the business world has had a large number of casualties resulting from the overhaul of practices, from high numbers of unemployed to business failures. For most workers,

there have been significant growing pains involved with the overhaul. The cartoon below reflects on three movements popular with today's new business order.



The Integrated Development Team (IDT), also referred to as the Integrated Product Team (IPT), employs the concept of better quality and more timely response by comprehensive participation of all relevant parties to a products creation. The Coach-Leader is a technically competent motivator in place of an administratively inclined middle manager. By empowering workers in IDTs, decision making can be expedited to those closest to the product. While these promises of business practice overhaul are reasonable, why is that that we continue to see struggles in implementation? As the continuation of the cartoon suggests, the struggles are in large part the normal difficulties in evolving to a new order with tools and habits developed under a different system for doing things. Changes will not seem painless to an individual until he or she has shifted the cultural understanding of what is personally right and wrong, good and bad, or black and white to his or her functioning in the workplace. This shift of culture will be quicker for some than others, and unfortunately, there will probably be those who never effectively make the shift at all.

The emerging environment for business conduct often seems chaotic, especially when compared to the relatively well defined structure of the Sequential Process/Organization Hierarchy model that prevailed during most of the 20th century. Many observers believe that the chaos is a by-product of change. In his book, *Showstopper*, G. Pascal Zachary documents the development of Windows NT™ at Microsoft, and includes this perspective on organized chaos within a company that symbolizes nouveau establishment:

> *"The saga of NT is a compelling instance of how one organization balances order and chaos, rules and serendipity, innovation and tradition. This task is messy, irrational and often painful. Born of conflict, innovation is dangerous because it hastens change, which is the main source of an organization's instability in the first place."*
> G. Pascal Zachary, *Showstopper,* 1994

Evidence suggests that the changes in business practices that are overhauling the way you and I work, will not go away. Within the defense industry, a comment often heard in the early days of the post-Reagan era of defense spending cuts was, "we will have to make this change until things get better." The attitude was that temporary adjustments were needed to weather the storm called the Defense Spending Crisis. In 1996, we see that the changes viewed as temporary in 1986, rather than abating, have become more intense. That industry has been marked by mergers, alliances, and product commercialization attempts for survival. Certainly the defense industry is and will remain a major sector of the economy of most developed nations. However, the size of the defense industry will continue to retract for the foreseeable future. Does this mean that people and companies should avoid defense business? While that is a personal choice, one thing seems clear - those seeking vitality in the defense and many other business sectors must be part of a learning organization. A learning organization is one best postured to take advantage of change rather than be victimized by it.

Peter Senge is the director of the Center for Organizational Learning at MIT's Sloan School of Management and the author of *The Fifth Discipline*, a work dealing with

learning organizations. The five disciplines that Senge cites as characteristic of a learning organization are personal mastery, mental models, system thinking, team learning, and shared vision. Not coincidentally, these disciplines are reflected in the attributes predicted by former Hanover Insurance CEO William O'Brien as, "necessary preconditions to cope with change." Mr. O'Brien is a member of the board of governors of the MIT Center for Organizational Learning. A summary of the attributes he sees as guiding principles for successful change follows.

William O'Brien's Attributes for Succeeding in the Future

Attribute	Characteristic
Empowerment	Self discipline replacing imposed discipline; aspirations, values, and visions replacing bureaucracy.
Systematic Understanding	Systems understanding replacing reductionist thinking; global interrelationship problem solving replacing piece by piece optimization.
Improved Conversation	Facing contentious issues and conflicts with impolite, but constructive conversation.
Voluntary Followership	Earning respect and loyalty

Mr. O'Brien recognizes that pragmatically, new attributes are not adopted and embraced overnight. Those attributes associated with success from the Sequential Process/Organization Hierarchy days, like efficient manufacturing, effective mass marketing, and financial acumen, will continue to be important in achieving business success. The business model envisioned is the marrying of the economic performance focus of the old with the individual growth appeal of the new. This can be called co-evolution, an environment where individuals and organizations have an opportunity to thrive together.

Evolving Parametric Estimating Methods

Parametric estimating has been in use for a long time. Anytime a relationship between a set of non-cost variables and cost is employed, parametric estimating is involved. My personal use began as a teenager, working for my father's construction business during school breaks. Most of my tasks were of the unskilled labor variety, but on occasion, I was sent to measure the room dimensions of a newly framed home for plaster bidding purposes. To prepare a bid, my father used a simple estimating relationship of total surface area to be covered (non-cost variable) and cost per square foot. The cost per square foot included all of his material and labor expenses to plaster a home. This simple parametric model was the essence of his new house plastering bidding system. There are many examples like this of parametric estimating from other business sectors and other times.

General purpose commercially marketed parametric estimating tools are a relatively recent development, with RCA's establishment of PRICE Systems (now a Lockheed Martin company) in 1975 being the first. Commercial models offer the advantage of commonality in language among clients using the models. The price that one must pay for both commonality and relevance (to the client's business) is an investment in tool adaptation and maintenance. In practice, this investment is also

incurred if an in-house developed special purpose tool is to evolve with a business, as it should. Going back to my personal example, the cost per square foot for new home plastering can not be used for industrial jobs (stores, churches, etc.), since the materials and codes are so different from the residential case. And, when the job is the remodeling of an old home, new factors for material removal, physical access limitation, and care of unmodified sections of the home need to be added. In addition, as his costs of materials and labor increased, so did the need for my father to update his cost factors. So, the need to adapt and maintain an estimating system is characteristic of an evolving business regardless of its method of acquisition - home built or commercially purchased.

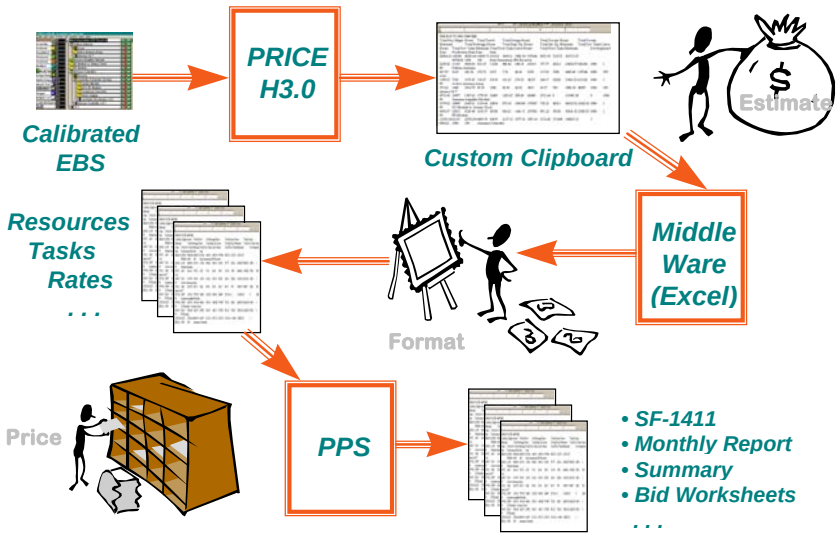
For its first 17 years, the PRICE models were accessed through the mechanism of time-sharing. In principle, this is very much like accessing the Internet today. A client logs into a remote computer using a local terminal and a telephone line interface, the modem. In practice, timesharing was much different than networking today. The limits of technology kept timesharing from supporting rapid transfer of large volumes of information. In addition, few clients could afford the cost of computing power needed to bring PRICE to the local terminal. In the late 1980s, technology had developed to the point where theses barriers began to fall. Now, all PRICE models are hosted on inexpensive personal computers. In fact, that is the only way to access PRICE - the timesharing computers were sold for parts in 1994!

Early timeshared versions of PRICE employed operating conventions that were almost like a unique foreign language. The jargon was usually unfamiliar to those being trained on tool use. The situation was not dissimilar to the learning of a programming language. The same strides that have been made in making programming more natural language like have also enabled PRICE model use to be more natural today than it was 20, 10, and even 5 years ago. As a product working under Windows™ control, PRICE operation is quick to master by anyone using that Graphical User Interface (GUI). Elimination of the special timesharing and model operation jargon and procedures has simplified the learning process to the point where material covered in a 10 day training session can now be effectively learned in fewer than 5 days.

More recent tool developments mark the beginning of a movement towards integration with tools in other business process environments of an enterprise. This began in 1993 with the integration of various PRICE models with each other. The hardware models for electronic component and module estimating, hardware assembly and system acquisition cost estimating, and life cycle cost estimating, once separate, are now totally integrated under one Estimating Breakdown Structure program. Soon, the software estimating model will be included in the single program architecture, along with the facility for adding client defined relationships. Progress is being made to cross the boundary that separates estimating tools from other tools. At this moment, PRICE is integrated into a prototype design tool known as RASSP, for Rapid Prototyping of Application Specific Signal Processors. The name of the project is not nearly as important as the goal - to reduce system design cost and time to market by a factor of 4! A critical element of meeting the goal is integration of a cost estimating tool (PRICE) with the design tools (requirements definition, functional decomposition, etc.) so as to provide immediate cost feed-back to designers. This is a working system that is gaining use within industry.

Most effective interfaces begin as multiple step processes that are refined as used to achieve optimal results. When a process reaches a consistent state of use, it is time to automate the interface. The interface of the PRICE H model to a proposal pricing system (PPS) is today a 3 step process of estimate, format, and price. To prepare for and/or transition to each of these steps in turn requires an intermediate operation or two. The graphic below illustrates the process. It is followed by a table to more fully describe the actions of each step.

PRICE H to PPS Interface



Step	Task	Process	Purpose
Estimate	Calibrated EBS	Construct model from technical information and related past performance.	Meet estimating criteria for sound basis of estimate.
	PRICE H3.0	Execute PRICE Hardware model	Generate labor, material, and other direct cost estimates.
	Custom Clipboard	Execute the customized clipboard report option of PRICE H.	Extract from PRICE H exactly the information needed for the Proposal Pricing System (PPS).
Format	Middleware	Execute intermediate software (Excel™) referred to as middleware.	Supplement the PRICE H data with any other information required of the PPS and create data formats required of PPS import facility.
	Resources, Tasks, Rates	Execute file save command of middleware.	Prepare the individual tables required by the PPS.
Price	PPS	Execute the PPS.	Prepare the pricing documents for bidding and budgeting.

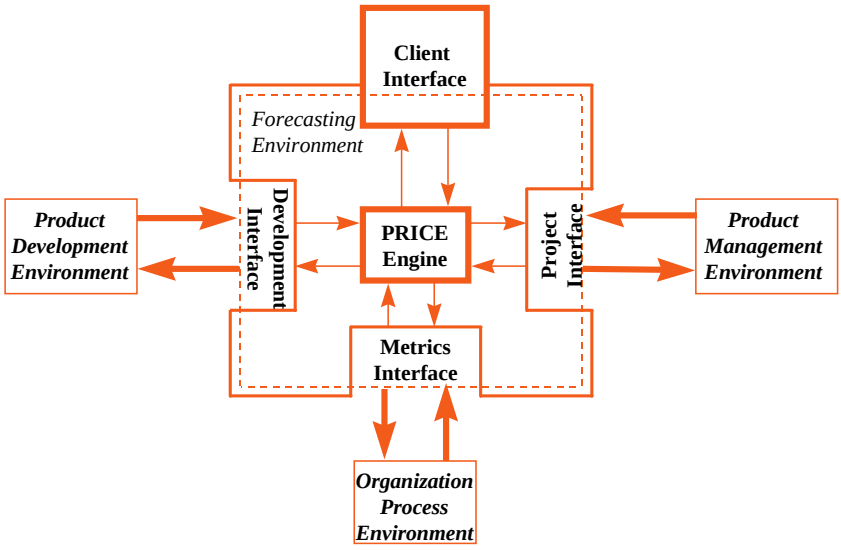
The process illustrated is in practice - it is not merely a concept. The interfaces from the estimating tool to the middleware to the pricing tool are all performed electronically using Windows™ commands of copy, paste, file import, file export, and file save. A sizable project can be thoroughly processed, beginning with the calibrated EBS to the proposal in less than an hour. Though a remarkable achievement, it can and should be

easier to do in less time. In this case, a reasonable approach to automating the multiple steps of the process would be to add the flexible data export and import capabilities needed for direct dialog between the estimating tool and pricing tool. Then, with the need for middleware eliminated, individual formats for specific pricing tools can be created once for each unique tool and applied as often as needed. Incorporated with technology like Object Linking and Embedding (OLE), the interface would allow the pricing program to be executed from within the estimating program, and vice versa. Now, consider further integration beyond these boundaries, and you have quality bids originating at the work station of an engineer putting the finishing touches on an assembly of a system that has been designed under a cost "watchdog." This is the foundation of virtual bidding.

The Future

Predicting the future is often called a fools game. However, in this case the momentum of the initiatives cited here is so great that it is more of a conclusion than a prediction that estimating will be integrated into business enterprise processes along with bidding. The only questions appear to be the order in which parts are integrated and the specific methods of implementation. A general view of how the system might look in 10 to 15 years is illustrated below.

The Future of P^{3}S - Virtual Bidding



The central theme of this view is complete integration of estimating (Forecasting Environment) with an enterprise's Product Development Environment, Organization Process Environment, and Product Management Environment. When fully implemented, there are two way interfaces to each of these environments, providing up-to-the-moment views of project cost, effort, schedule, risk, quality and features. The interfaces will interpret information about the project in question, using the output of tools used by the enterprise to develop, manage, and execute projects. The view will therefore change as the project changes. This direct linking to other business tools assures the most

objective, relevant, and comprehensive forecasts. Integration of the tools requires that a common vernacular be used.

As a stand alone tool, PRICE can forecast through the Graphical Client Interface to the estimating engine. The client operating PRICE can direct the engine to interface to the three lateral environments for information retrieval. Results are sent back to the client in the form of screen views, graphics, and printable reports. This mode of PRICE operation is referred to as stand alone, where the client serves as the proxy for information about product properties, metrics, and performance. In this mode, the client directs the entire forecasting process, including interfaces to supporting environments. In it's fully integrated mode, the concept takes on a much broader definition of client. For example, a developer becomes a PRICE client, communicating information about specific product properties directly from a development tool through an interface to PRICE. That interface interprets and translates the engineering information into PRICE terms, executes the engine, and reports information back to the engineer/client in his/her vernacular. A similar process is employed if the client is a quality assurance engineer working in the process environment or a project manager working in the product management environment. Even when operating in the fully integrated mode, the client will have access to PRICE through specific tool interfaces (like OLE Server) in order to seize control when desired. The path from stand alone mode (today) to fully integrated mode (the future) will be evolutionary, with more tools in each environment enveloped over time.

Creating a view of, "integrated wonderland" is useful in visualizing possibilities. And, while there is little doubt that something like this will evolve, there is also little doubt that it will be as neat and tidy as the picture portrays. Further, there is the matter of what to do while the virtual bidding machine evolves. For advice, it might be worthwhile to turn to James Moore, author of *The Death of Competition,* who cites coevolution, and not competition in the traditional sense of the word, as key to strength in today's business environment. Coevolution means supporting and encouraging those who, in the past might have been viewed as competitors, while developing your own talents. For parametric estimators, that might mean:

1. Supporting and encouraging local estimating initiatives - parametric and others. Everyone seems to recognize that cost is an issue to no longer ignore, but very few know where to begin. An estimator seems like a natural leader for any cost related initiative. There will be leaders - decide if you want to be one.
2. Staying in school - specifically computer school. The computer has replaced the typewriter, the desk calculator, a lot of paper and pens, and some jobs. It's influence on your personal and business lives is unlikely to diminish. Teach the computer to serve your needs.
3. Participate in areas of personal strength. We all do best at that we enjoy. There are plenty of challenges for everyone, so attack those where you feel most confident in your abilities, and leave others for fellow coevolutionists.
4. Relax. Coevolution, empowerment, systematic thinking, technological advances, estimating initiatives, and all of the other converging movements discussed here are creating an interesting work setting for the individual: one in which a great number of people are working for you, while at the same time, you are also working for them. It

has a characteristic that distinguishes the championship sports team from the also-rans: fearless accountability commitment from all members.

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