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SPS AND BEYOND: INNOVATING ACQUISITION THROUGH INTELLIGENT ELECTRONIC CONTRACTING

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The Standard procurement System (SPS) uses information technologies (IT) to support defense procurement through workflow technology. Although SPS has overcome many of the severe pathologies associated with the Defense procurement process, it is only a humble beginning for the application of state of the art in electronic contracting. This article outlines key aspects and limitations of next-generation information technology including waivers of cost and pricing data and other price analysis methods. SPS officials are challenged to investigate and incorporate these powerful technologies into future electronic contracting systems to improve procurement process performance.

Society is amidst the “third wave” (Toffler, 1980), the information age in which knowledge capital is becoming more important than traditional economic inputs of labor and finance (*Forbes ASAP*, 1997). The nature of work is changing dramatically, and the structure of modern organizations must shift even further to accommodate this quantum change. New organizations are beginning to resemble symphony orchestras more than military commands (Drucker, 1988), and information technology (IT) has become central to process performance

and competitiveness in the enterprise (Davenport and Short, 1990).

CONTRACTING IN THE DIGITAL AGE

Indeed, most enterprises—including corporations, government agencies, military commands and others—are actively involved with IT-focused process redesign (Bashein et al., 1994). This comes under the rubric of business process reengineering (Hammer and Champy, 1993), process innovation (Davenport,

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1993), process improvement (Harrington, 1991) and other monikers for post-total quality management efforts effecting “radical” change and seeking “dramatic” performance improvement (Hammer, 1990). Such radical change and dramatic improvement have effected a fundamental restructuring of the global economy, enabled many enterprises to downsize by 50 percent or more while becoming more flexible and responsive, and sent the market capitalization of knowledge and technology organizations (e.g., Microsoft, Intel, Cisco) to record heights.

The restructured global economy is more demanding—and less forgiving—now than it was even a decade ago when the reengineering phenomenon began. Technology is advancing exponentially, product cycles are shortening logarithmically, global hypercompetition (D’Aveni, 1994) is intensifying, virtual organizations (Davidow and Malone, 1992) are forming along with electronic markets (Malone et al., 1987), and product supply chains are growing increasingly dynamic, critical, and unstable. For example, it is not uncommon to observe groups of firms engaging in strategic partnerships, joint ventures, and integrated supply chains on some products and services, yet competing aggressively and litigating contested intellectual-property rights with the same “partners” in other markets. And most enterprises are simultaneously reducing their supplier bases while searching ever deeper for new product, service, and information innovations and providers.

Further, the speed at which dynamic topologies of supply webs (i.e., networks of individual supply chains) change now outpaces human managerial capabilities. And managing the enterprise supply chain

has never been more difficult, or more important. Indeed, many progressive firms now view procurement as a strategic enterprise process (Gebauer et al., 1998). For instance, many procurement executives are now charged with identifying and developing strategic alliances and joint partnerships, orchestrating vendor-managed inventories, just-in-time delivery of mass-customized products (Pine et al., 1993), participative design, and concurrent engineering across organizational boundaries, and maintaining trust-based relationships—as opposed to executing arms-length transactions—with customers and vendors along the supply chain. As a result, such leading executives require new business skills and need to operate with greater knowledge and speed than ever before.

Procurement and contracting are central to supply-chain management and they have become classic exemplars of knowledge work. Although IT is used to support and streamline many clerical and administrative tasks along the supply chain, the key intellectual activities of such knowledge workers have been stubbornly resistant to process redesign and innovation (Davenport, 1995). In fact, recent case studies of “high-performance” procurement organizations (e.g., see Nissen, 1997) continue to reveal an unimaginable reliance on manual, paper-based, labor-intensive processes that have changed surprisingly little in the half century of IT-based procurement support.

For example, a computer sits on nearly every desk in most procurement organizations, but the critical knowledge work of procurement is not computer-based (Nissen, 1996). Workflow automation (White and Fischer, 1994) and electronic data interchange (Sokol, 1996) enable

digital communication between workers, departments, and organizations, but the procurement work itself still centers on paper documents and forms (granted, now transmitted and printed by computer). IT collaboration tools are becoming available in the marketplace (see Rayport and Sviokla, 1994), but supply-chain managers still overwhelmingly rely on the telephone to coordinate most procurement activities (Gebauer et al., 1998). Some intelligent information-finding agents are being implemented to identify potential trading partners and supply sources, but these simple agents possess only weak domain knowledge and are incapable of enacting the necessary managerial steps required for supply-chain performance. Rather, most key knowledge-work activities are performed by procurement people, not computers, in the traditional, slow, inflexible, unreliable manner no longer appropriate for the dynamics, complexity, and criticality of supply-chain management today.

The objective of this article is to outline key aspects and limitations of the next generations of IT for electronic contracting—focusing in particular on knowledge systems and intelligent agents—against the backdrop of current technology: the standard procurement system (SPS). First is a brief overview of SPS emergence, which summarizes key findings of a recent academic study investigating advanced procurement processes in the Department of Defense (DoD). Based on this study, the paper then continues with discussion of electronic contracting beyond SPS, as systems for powerful procurement-process innovation are identified and described. The paper subsequently closes with important conclusions from the study.

STANDARD PROCUREMENT SYSTEM EMERGENCE

Standard procurement system is the name for a new application of IT to the domain of military procurement and contracting. Providing integrated support for many activities on the buyer side of (DoD) supply chains, it is essentially workflow technology (see White and Fischer, 1994) adapted for military procurement and contracting. Designed to interface with legacy systems as well as current technology such as electronic data interchange (EDI), electronic commerce bulletin boards, and on-line regulations (e.g., the *Defense Acquisition Deskbook*), SPS moves the DoD forward into the next century.

Interestingly, early SPS requirements and potential for process improvement were revealed in an applied academic study of the Navy procurement process (Nissen, 1996). This intensive, multiple-case study centered on process analysis and redesign and investigated the key procurement and contracting processes involved with a large, multisite command on the West Coast. This particular command was originally selected because it represented an exemplar of innovation in procurement and contracting (e.g., as a Hammer Award recipient), and working through a reinvention laboratory, management was favorably inclined to push barriers to effective contracting through IT. Nonetheless, the study identified a number of serious

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process pathologies—including manual, paper-based, labor-intensive, regulation-laden processes with narrow tasks conducted serially by specialists handing off work from one bureaucratic department to another—and recommended an aggressive set of IT-based redesign transformations. The highest-potential redesign alternatives were then simulated to assess the likelihood of performance improvement.

One of these redesign transformations involves the use of workflow technology to support what was a completely manual, paper-based procurement process at the

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time. The simulated performance of this workflow-enabled redesign is impressive, with dramatic procurement administrative lead-time (PALT) reductions for some processes. For example, simulated performance of the justification and approval (J&A) process suggests a two-thirds reduction in cycle time as likely. Other processes such as RFP preparation have more moderate gains (Nissen, 1997). Based in part on results from this study—and in conjunction with other efforts through the reinvention lab—the contracting organization decided to move into workflow technology and engaged a commercial software provider to adapt an implemented system to support military procurement.

Early experience with the operation and analysis of this procurement workflow system, called "Procurement Desktop" at the time, served as a motivational

exemplar for efficient IT-enabled procurement and provided the impetus for DoD-wide development of the system now known as SPS. Indeed, the developer of Procurement Desktop won the SPS contract award for a design with comparable capability and is busily installing systems and training DoD contracting professionals at the time of this writing.

Early operational results from organizations now using SPS are beginning to confirm academic findings with respect to cycle time made in the study noted above, but a number of SPS-driven problems are emerging simultaneously. These include, for example, lack of SPS systems integration, incomplete SPS functionality, inadequate training and computer-hardware budgets, and resistance to change in contracting organizations (see McCarthy, 1998). Nonetheless, the SPS represents a significant step forward in contracting technology, and its implementation promotes development of the kind of IT infrastructure required to support the more advanced and powerful electronic contracting technologies; that is, it paves the way for electronic contracting beyond SPS.

ELECTRONIC CONTRACTING BEYOND SPS

Clearly, the workflow technology underlying the current generation of SPS represents only a humble beginning to advancing the state of the art in electronic contracting. For example, other findings from the academic study above identify much greater potential for dramatic improvement in process performance, as well as critical limitations to current SPS technology. Three of these findings are highlighted here.

NEGLECTIBLE COST IMPROVEMENT THROUGH SPS

SPS implementation is unlikely to reduce procurement-process cost significantly. This first finding surprises many people in the contracting organization. In stark contrast with the impressive reductions in cycle time mentioned above, simulated activity-based cost for processes redesigned through workflow technology such as SPS shows negligible improvement over the manual, paper-based, labor-intensive process baselines. "The simulation models must be wrong," was the initial reaction from process managers and participants. But the simulation models are carefully constructed and validated before use, and no one questions their results, pointing to dramatic cycle-time reductions. Indeed, the simulations reveal a critical limitation of workflow technology when it is simply overlaid on top of an existing process.

In fact, closer analysis reveals the process steps themselves are fundamentally unchanged by the workflow system. The same people from the same departments are performing the same process tasks, in the same serial sequences, handing off essentially the same work from one to the other as before. Only the interface to these process tasks (i.e., electronic vs. paper-based) has changed. Of course the intermediate work products are communicated more quickly through the technology, but this represents the cycle-time effect discussed above. The same "broken" process can simply operate faster in a broken state through such technology. Indeed, when other IT-based costs such as personnel training, computer-hardware upgrades, network administration, and software maintenance are considered, activity-

based cost can actually increase through workflow technology such as SPS!

This result comes as no surprise to the investigators, for without fundamental change to the underlying work process itself, simply inserting IT such as SPS is colorfully described as "paving the cowpaths" and "automating the mess" (Hammer, 1990). Through the current generation of SPS and prevalent design of procurement processes in the DoD, this colorful description depicts the current state of the art in military contracting today.

KNOWLEDGE SYSTEMS COST IMPROVEMENT

The academic investigation also includes a redesign transformation to advance the state of the art in military contracting. Specifically, a major opportunity for process innovation is identified through what is expected to power the next generation of SPS: knowledge systems. Knowledge systems involve the

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application of artificial intelligence (AI) to assist with some key knowledge-work activities performed by procurement and contracting personnel. The procurement domain is actually well suited to AI-enabled innovation, as processes are clearly delineated and procedural information is often thoroughly documented (e.g., through the Federal Acquisition Regulation [FAR]). The idea is to capture, formalize, and embed procurement and contracting knowledge into the workflow system. Thus, not only does this next-generation IT support procurement workflows

(e.g., like SPS) through electronic infrastructure, but it also provides intelligent assistance to procurement and contracting professionals, in much the same way that more experienced and expert contracting personnel are responsible for assisting junior and less-experienced personnel today.

As examples, an intelligent contracting module can be used to assist a contract

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specialist with identifying and adhering to the proper procedures to follow in a given procurement. By interpreting user requirements and ac-

cessing the FAR and other applicable regulations (e.g., the DoD FAR Supplement [DFARS], Navy Acquisition Procurement Supplement (NAPS), such an intelligent module can guide the contract specialist through the steps of the procurement, ensure he or she conforms to regulation and statute, and increase the effective experience and skill level of this knowledge worker. Such a module can relieve some of the current oversight and management burden on the responsible procurement contracting officer (PCO) and actually improve process quality as well as cost. Indeed, simulated process performance corresponding to this AI-based redesign differs from its workflow-only counterpart above by reducing cost and cycle time for the process (See Nissen, 1997 for details).

Another example of AI-based contracting assistance supports the PCO directly. Consider, for instance, the many reviews performed by PCOs today (e.g., of J&As,

draft RFPs, determinations, and findings). With knowledge systems technology appropriately developed to assist the contract specialist and ensure compliance with regulation, policy, and prudence, many of the perfunctory reviews may not need to be performed at all. Moreover, complementary PCO-oriented technology can even be applied to perform these reviews automatically. Of course, AI technology is not magic, nor does one expect (or desire) to completely replace PCOs. Rather, one should look to this advanced IT to augment and enhance the PCO. This can relieve these key process participants from the routine and perfunctory duties currently required and equip them with the ability to focus their attention and effort on the difficult, unusual, and complex procurement problems more appropriate for their considerable knowledge and experience. Perhaps PCO-oriented processes should be redesigned using something of an "80/20 rule," in which knowledge systems are used for the majority of work (e.g., 80 percent) that is routine and perfunctory, reserving the balance for problems more deserving of PCO attention.

Research along these lines has been ongoing for some time (e.g., at the Naval Postgraduate School) and such intelligent contracting systems are not in the realm of science fiction. Rather, proof-of-concept systems have been constructed through straightforward application of knowledge technology to the domain of military procurement and contracting (e.g., see Nissen, 1999). Further, it is interesting to note the initial SPS specifications included some references to intelligent capabilities. However, there is little in the way of intelligence in the current SPS implementation.

Yet AI technology is well within current capabilities of many universities and some commercial contractors today. Indeed, AI represents the easy part. The difficult task is formalizing the knowledge, which requires expertise in contracting as well as AI. Because few knowledge engineers (e.g., AI professionals) possess in-depth procurement knowledge, and even fewer contract specialists are trained in AI, intelligent-contracting functionality is unlikely to be seen until the next generation of SPS. The requisite technology exists and has been demonstrated. It now remains for SPS officials to investigate knowledge systems and plan for incorporation of this technology into SPS.

INTELLIGENT CONTRACTING AGENTS

The power of AI and IT does not stop with the kinds of knowledge systems discussed above. Although such static, advisory systems are powerful and offer good potential for dramatic performance improvement in terms of cost and cycle time, still more impressive process redesigns emerge from introduction of intelligent agent technology into the supply-chain process. Intelligent agents are autonomous, network-mobile software entities capable of performing work at various process locations (e.g., in the contracting office, at one or more offerors' sites) and acting responsibly on behalf of their owners with the same kind and level of intelligence described through the systems above. For example, an intelligent contracting agent can be designed to interpret a set of requirements, prepare a regulation-compliant request for proposal (RFP) or quotation (RFQ), identify potential supply sources, and conduct market surveys. Further, these agents can

move to potential suppliers' locations and collaborate with supplier agents to prepare responsive proposals, and then return to the contracting office, summarize the various proposals or quotations received, and make a preliminary source-selection recommendation. The cost and PALT savings possible through this powerful, exciting technology should be obvious.

A newer area of research than knowledge systems above, intelligent contracting agents is more representative of the generation after next of SPS. But laboratory prototypes exist today that are designed to effect just this kind of supply-chain integration and management. For instance, a prototype set of intelligent sup-

"...still more impressive process redesigns emerge from introduction of intelligent agent technology into the supply-chain process."

ply-chain agents is being examined in terms of its performance of commercial software acquisition (see Nissen and Mehra, 1998) and agent-development tools are improving with each agent-based academic conference (e.g., see Mehra and Nissen, 1998). Figure 1 delineates the process steps performed by these agents and their path between user, supply, and contractor locations.

Clearly, intelligent-agent technology is not limited to procurement and contracting. For example, an intelligent program management agent can be designed to:

- interpret the software requirements of a major weapon system;

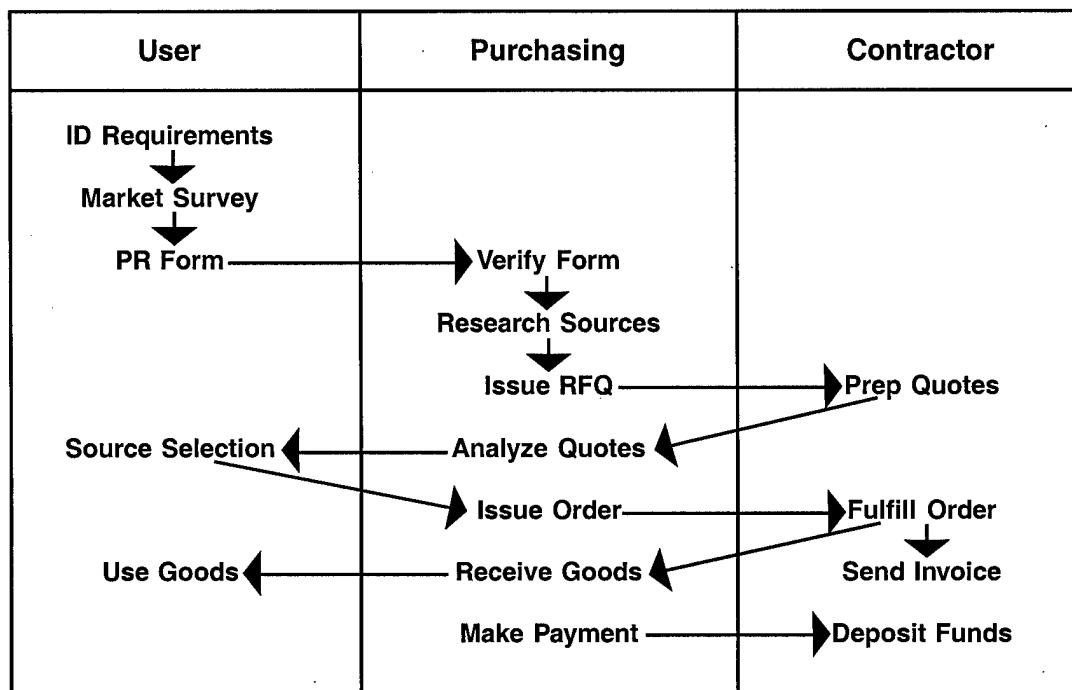


Figure 1. Software Supply Chain Process

- analyze the corresponding RFP for inclusion of the appropriate standards, requirements, reviews, and data items;
- evaluate offerors' proposals, software development plans, and past performance data; and
- even interpret post-award performance data (e.g., software metrics, cost/schedule status reports).

Intelligent logistics agents can similarly be designed to analyze deployment plans, monitor external events, advise contractors of likely surge requirements, and even re-plan with changes to world events and the global environment.

This technology can clearly advance the state of the art in electronic contracting,

but it follows directly from, and synergistically augments, current and next-generation IT-enabled process redesigns discussed above. Simulated performance of agent-based contracting processes indicate even more dramatic performance gains in terms of cost, cycle time, quality, flexibility, and other desirable metrics, and prototype performance to date is encouraging. Even graduate students are beginning to involve themselves with this technology through thesis work, and one can anticipate intelligent contracting agents to be ready for the DoD procurement environment far in advance of the DoD being ready for agent-based contracting. Readiness notwithstanding, this represents the future of contracting in the digital age.

CONCLUSIONS

The Standard Procurement System represents a significant step forward to overcome many severe pathologies associated with the DoD procurement process. However, a number of problems are emerging in conjunction with SPS implementation, and it clearly represents only a humble beginning to advancing the state of the art in electronic contracting. Moreover, simulated process performance studies indicate that although the workflow technology underlying SPS offers good potential for cycle-time reduction, management should anticipate only negligible cost reduction, at best. When training, support, and maintenance costs are included; process cost may actually increase through SPS implementation and operation.

Alternatively, the next generations of IT, incorporating AI technologies, offer potential to dramatically reduce both cost and cycle time of procurement processes and our understanding of such technologies suggests other benefits as well, such

as increased process quality and consistency. The AI technology associated with knowledge systems is now quite mature and has been successfully demonstrated in many domains with great similarities to defense procurement. This study finds that knowledge system tools can be employed to support both contract specialist and PCO work and may represent the next generation of SPS capability. For the generation after next, intelligent agent technology can further streamline, automate, and support procurement and contracting through software representatives that traverse networks to represent buyers and sellers in procurement transactions. With working proof-of-concept systems now being studied in the laboratory, the generation after next of SPS may follow closely behind the employment of knowledge systems. It now remains for SPS officials to investigate and plan for incorporation of these powerful technologies into electronic contracting systems beyond the current SPS.



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