

REENGINEERING THE RFP PROCESS THROUGH KNOWLEDGE-BASED SYSTEMS

Dr. Mark E. Nissen

Acquisition plays a vital role in national defense of the United States. But, defense acquisition can be quite difficult, and few would argue that current acquisition processes perform in an optimal manner. The magnitude of change mandated by FASA and DAWIA, along with changes mandated from within DoD, is such that “business as usual” no longer represents a viable alternative for acquisition management. The military procurement process in general requires reengineering, and the research described in this paper focuses upon the Request for Proposal (RFP) subprocess in particular. The use and utility of a knowledge-based system to support process redesign are demonstrated, and insight is provided into the potential of AI-based technologies to dramatically improve military procurement. The results provide the basis for a number of conclusions that are important for the acquisition professional, and establish an agenda for future research.

Acquisition plays a vital role in national defense of the United States. The armed forces depend on the acquisition of high-quality and reliable weapon systems, equipment, support, and services for their defense missions, in peacetime as well as during periods of international tension and conflict. But getting what is needed can be quite difficult. Because many of these systems are exceedingly sophisticated, complex, and expensive, their procurement is complicated and involved. Further, those whose job it is to acquire systems and services work in an environment of arcane laws, regulations, policies, and procedures, for which a considerable investment in education

and training is required. And, this legal and regulatory environment is constantly changing, which requires vigilant attention and incessant retraining of acquisition professionals so that their knowledge remains current.

Moreover, few would argue that current acquisition processes perform in an optimal manner. Rather, the costs required to staff and manage defense procurement consume a substantial portion of acquisition funding, and procurement administrative lead time (PALT) represents a major factor in weapon system planning and logistics. Indeed, legislation such as the Federal Acquisition Streamlining Act (FASA) and the Defense Acquisition

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Workforce Improvement Act (DAWIA), along with changes (e.g., performance specifications and standards, preference for commercial items, integrated process teams) mandated from within the Department of Defense (DoD), require dramatic improvement in performance of the military procurement process. To exacerbate the difficulties inherent in this performance-improvement task, the mandates come at a time when defense appropriations are declining substantially, acquisition staffs are getting much smaller, and many procurement organizations are now obligated to fund themselves on a fee-for-service basis (i.e., Defense Business Operations Fund (DBOF)).

The magnitude of required improvement is such that “business as usual” no longer represents a viable alternative for acquisition management. Neither can management expect to achieve process improvements of the magnitude required through the incremental methods (Hammer & Champy, 1993) of continuous process improvement (CPI); rather, the kinds of dramatic performance improvements that are needed call for radical process redesign (Hammer, 1990)—that is, the military procurement process requires reengineering.

REENGINEERING

Business process reengineering (BPR)—which is also referred to as business engineering (van Mael, 1993), process innovation (Davenport, 1993), process redesign (Davenport & Short, 1990), and simply reengineering (Hammer, 1990)—has been defined as “. . . the *fundamental* rethinking and *radical* redesign of business processes to achieve *dramatic* improvements in critical, contemporary measures such as cost, quality, service, and speed [emphasis added]” (Hammer & Champy, 1993, p. 32). The *fundamental* nature of reengineering relates to questioning assumptions; that is, taking nothing about a business or organization as fixed or given, and challenging the appropriateness and existence of every aspect of business organization and operation. “Radical” redesign refers to transforming even the most enduring, stable, and central aspects of a design configuration, and envisioning new redesign alternatives without limitations or constraints associated with a current design. “Dramatic” improvement implies that the level of performance is expected to increase by several fold (e.g., 2x, 5x), as opposed to incremental improvements that are generally measured in percentages (e.g., 5%, 20%).

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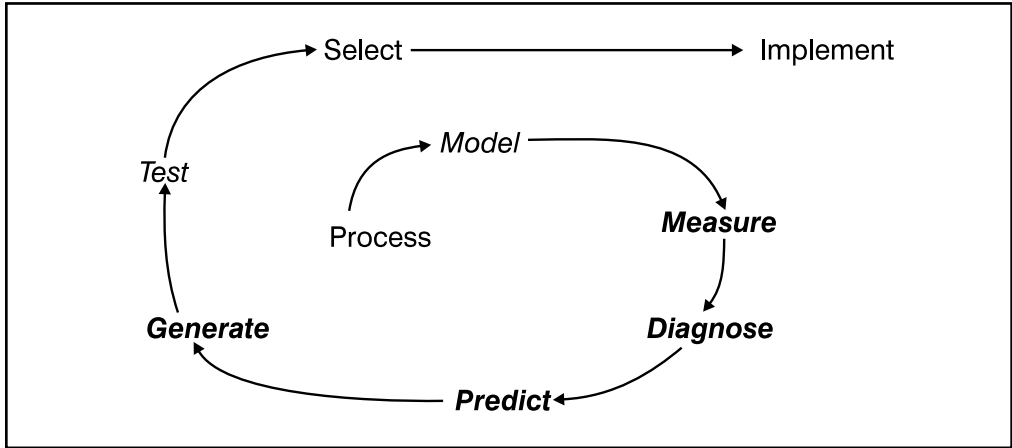


Figure 1. KOPeR Redesign Methodology

Although the focus of BPR has been primarily on the private sector, many federal agencies are also actively involved with reengineering. These federal reengineering endeavors generally fall under the rubric of the “reinventing government” program (U.S. Government, 1993a), and have led to the development of several “reinvention labs” (U.S. Government, 1993b) across the country. Numerous cases of reengineering in the government sector can be found in Electronic College (1996). Although military organizations and processes have a number of unique attributes, many of the tools, technologies, methods, and redesigns from *business* process reengineering apply equally well to *organizational* processes such as military procurement. One such currently emerging technology is knowledge-based reengineering.

KNOWLEDGE-BASED REENGINEERING

The term *knowledge-based reengineering* refers to the use of knowledge-

based systems (KBSs) to automate and support process redesign. Integrating some powerful methods and technologies of artificial intelligence (AI) with a number of expert reengineering methodologies from the consulting practice, the knowledge-based system KOPeR (knowledge-based organizational process redesign) (pronounced “cope-er”) was designed to provide automated reengineering support (Nissen, 1995). The KOPeR design draws from the AI methods and technologies that led to the development of many powerful KBSs, each of which has enabled dramatic improvements in organizational processes. These include, for example, the R1/XCON system (McDermott, 1982), MYCIN (Shortliffe, 1976), SOPHIE (Brown et al., 1982), the CLUES system, and the Authorizer’s Assistant (Laudon & Laudon, 1994, pp. 599, 606). Many such “intelligent” systems have demonstrated professional levels of performance that meet and exceed those of engineers, physicians, and financial managers.

Figure 1 delineates the *redesign methodology* supported by KOPeR. An orga-

nizational process in the field is first represented in terms of a computer-based model; such computer-based modeling now represents standard reengineering practice, and the Integrated Definition family (e.g., IDEF 0, IDEF 3) provides a standardized representational formalism for modeling organizational processes. Because the IDEF (and nearly all other BPR modeling) tools are graph-based (i.e., comprised of nodes, edges, and attributes), a battery of graph-based diagnostic process

"KOPeR and its corresponding redesign methodology were used in an investigation to reengineer several processes associated with military procurement."

measures can be obtained *automatically* by KOPeR. As diagnostics, these measurements are used to detect the severe pathologies and faults associated with

a process, and KOPeR employs its base of formalized reengineering knowledge (i.e., knowledge base) to predict which redesign transformations are most likely to effect dramatic improvement in process performance. These transformations are then applied to the baseline (i.e., "as is") process model to generate one or more redesign alternatives for the process (i.e., the "to be" scenarios).

Finally, once a *dynamic* process model has been validated and calibrated against the process baseline, simulation is employed to test the performance of each redesign alternative. This represents a very efficient technique to evaluate alternate process redesigns, and to reduce the inherent risks of reengineering before committing time and money to a problematic implementation. Standard methods of

evaluation and decision making (e.g., cost/benefit analysis, functional economic analysis, multi-attribute decision making, etc.) can be used to select the highest potential redesign alternative, which then becomes the focus of organizational planning and implementation.

REENGINEERING THE RFP PROCESS

KOPeR and its corresponding redesign methodology were used in an investigation to reengineer several processes associated with military procurement. A major Navy procurement organization was the focus of this investigation, in part because its organization, processes, and technologies appear to be representative of those found across any number of military sites and bases; hence the results from this investigation are inherently generalizable, not only to other Navy organizations, but to procurement processes across the range of service components, government agencies, and major corporations. This Navy procurement organization is part of a national reinvention laboratory, which, by definition, has expressed an explicit interest in process innovation, and it is also perceived to be well-managed, having already institutionalized Total Quality Management (TQM), and achieved a number of impressive process improvements (e.g., the use of electronic data interchange [EDI] and bankcards for small and micro purchases, respectively). Because these procurement processes are acknowledged to perform relatively well to begin with, we have a good opportunity to demonstrate the use and utility of KOPeR and knowledge-based reengineering.

Table 1: Key RFP Process Measurements

Measure	Value
Process size	255
Process length	255
Parallelism	1.00 *
Handoff fraction	0.24
IT-Support fraction	0.08
IT-Communication fraction	0.00
IT-Automation fraction	0.00 *
* indicates theoretical minimum	

RFP PROCESS MEASUREMENTS AND DIAGNOSTICS

Table 1 summarizes a subset of the key RFP process measurements and diagnostics. The process size (255) measures the number of activities required for an RFP, the magnitude of which indicates that the process is relatively large; process size is generally related positively to activity-based cost (O'Guinn, 1991), whereas process length is thought to drive activity cycle time (Stalk & Hout, 1990). The parallelism measurement (size divided by length) represents a theoretical minimum for that measure; that is, the value (1.00) indicates that the RFP process flow is entirely sequential, with each of its activities performed in a strict linear fashion. The handoff fraction measures the percentage of process activities associated with organizational handoffs; handoffs are generally associated with work sitting in in-boxes and out-boxes—awaiting assignment, performance, reviews, and managerial approval—which adversely affects process cycle time. By comparison with

other procurement processes, the value (0.24) obtained for the RFP suggests that much of the PALT associated with this process may be driven by handoffs.

The fractional metrics associated with information technology (IT) measure the density of three classes of IT in organizational processes: support, communication, and automation. The IT-Support measurement (0.08) is very low for the kind of knowledge- and information-work involved in the RFP process, and indicates that most process activities are performed manually. Worse, the IT-Communication fraction is indistinguishable from zero (to 2 decimal places), which indicates that nearly all process communications are paper-based. Moreover, the IT-Automation fraction (0.00) reflects the theoretical minimum for that measure, which indicates a labor-intensive process.

To summarize, the baseline RFP process represents a labor-intensive, linear sequence of manual, paper-based activities that are interspersed between numerous handoffs and reviews. The implication is that the process has a number of

pathologies and faults, which appear to adversely impact its cost and cycle time. Recall that the RFP process is *currently* considered to represent a well-managed set of acquisition activities. Having diagnosed these pathologies and faults, KOPeR next concentrates on reducing process linearity through a workflow transformation, and applies three IT-based redesign transformations to overcome the manual, paper-based, labor-intensive shortcomings of the process. KOPeR employs these transformations to generate the redesign alternatives below.

REDESIGN ALTERNATIVES

Referring back to the methodology depicted in Figure 1, KOPeR utilizes its measurements and diagnostics to predict one or more redesign transformations that have good potential to effect dramatic performance improvement through process innovation. The methodology also calls for a team of process experts from the procurement organization to review all of the KOPeR-generated transformations, using criteria such as feasibility, implementability, perceived benefit, and the like. Of the 40 or so redesign transformations predicted by KOPeR, the corresponding measurement information helps the team of experts to focus on three IT-based enabling technologies that are perceived to have the highest potential for improvement: a) procurement workflow systems, b) expert review systems, and c) knowledge-based composition systems. As an aside, the reader should note that current reengineering practice (e.g., Davenport, 1993) guides against process innovation based *solely* on IT-based transformations,

yet IT continues to represent the *central* enabling technology for process redesign. These transformations are discussed in turn.

Procurement workflow systems. Workflow systems can enable the kinds of IT-based process support and communication that are absent from the baseline RFP process. Workflow systems provide a computer-based infrastructure for the routing, storage, and support of electronic documents, which can greatly reduce the time required for work to move between activities. The basic workflow system used to support the RFP process combines features generally associated with a database management system (DBMS) for indexed storage and retrieval of work documents at various stages of completion, along with those of an electronic communication application such as e-mail, which can be used to transmit work documents to the various organizational agents involved in a process. Additionally, the sequence of steps and agents involved in a process is generally enumerated beforehand, and used to automatically route work to the proper agent, when the work is required to be completed.

Other system capabilities can include templates to describe the overall flow of work in a process, along with on-line process “help” and reference information (e.g., regulations, contract clauses, etc.). A number of commercial workflow applications is available on the market, and several firms have expertise in customizing workflow applications to support a particular organization and process such as Navy RFP preparation. The implementation of workflow systems requires a considerable investment, however, not only

in computer hardware, software, and development, but also in personnel training, system maintenance, and process control. Interestingly, at the time of this writing, the process participants also indicate that a decision has been made to purchase, customize, and implement just such a procurement workflow system.

Review expert systems. Expert systems are capable of performing many of the reviews required by contracting officers and lawyers, and can enable the kind of IT-based automation of process activities that is missing from the baseline RFP process. The expert systems transformation addresses the various high-level reviews of RFP documents that are conducted by contracting officers (KOs) and legal representatives. These important reviews prevent errors and mistakes from affecting RFPs and subsequent contracting activities downstream in the acquisition process, and they require considerable skill and experience on the part of the KOs and lawyers involved. Hence, this requires relatively sophisticated AI technology required to reproduce the performance of such highly skilled experts.

Alternatively, a great many aspects of military procurement are governed by laws and regulations, which are articulated through the U.S. Code (USC), Federal Acquisition Regulations (FAR), Defense FAR Supplement (DFARS), and other widely distributed documentation; hence, many of the RFP reviews offer good potential for automation via (esp. rule-based) expert systems. Although complete automation is impractical (and probably undesirable), the review tasks can still be shared between human and computer agents. For example, following something

of a “80/20 rule,” if 80 percent of RFP reviews are routine and perfunctory in nature, then these can be assigned to the machine agent; the human experts (i.e., KOs and lawyers) can then handle the remaining 20 percent that are more difficult or complex. Such a scheme for (human/machine) task sharing has precedence in industry (e.g., engineering design, credit review, loan approval), and, although its transformation is predicated on relatively

sophisticated AI technology, the regulation-based nature of the acquisition domain makes it nearly ideal for expert systems development. Indeed,

“Although complete automation is impractical (and probably undesirable), the review tasks can still be shared between human and computer agents.”

this transformation in no way pushes against the frontiers of AI in computer science; rather, it represents the adaptation of established technology to the acquisition domain, and the kind of expert RFP review systems described here is well within current expert systems capabilities.

Composition knowledge-based systems. Knowledge-based systems are similar in spirit to the expert systems above in that they automate tasks. The primary difference lies in the sophistication of knowledge-based systems, as they do not require performance at the level of an *expert* (e.g., KO, lawyer); rather, their level of knowledge and performance is lower, more on the order of an *analyst* or information worker like the Contract Specialist (CS). As such, the technological challenge is greatly reduced, even from that of the review expert systems above, yet the poten-

Table 2: Redesigned RFP Process Performance

Redesign Alternative	Cost	Cycletime
Procurement Workflow Systems	nil	28%
Review Expert Systems	11%	33%
Composition KBS	52% *	67% *
* Exceeds performance-doubling threshold.		

tial for dramatic performance improvement remains. This makes the KBS redesign very attractive.

The work to be accomplished by such knowledge-based systems involves document composition. This generally entails activities such as (a) reviewing the background information and requirements associated with a procurement; (b) describing the supplies and services to be procured; (c) selecting the appropriate clauses, specifications, and standards; (d) outlining proposal instructions, schedules, and delivery information; and (e) using these elements to compose the proper RFP sections. Depending on the level of desired "intelligence" and functionality, a composition KBS can also be developed to make recommendations regarding contract types, incentives, and other higher-level activities, in addition to being embedded directly into the kind of procurement workflow system described above. Indeed, in the simulations that follow, such a procurement workflow system is *presumed* to exist, and provides a digital document infrastructure to support both RFP composition and expert review. As above, complete automation of the RFP document composition process is imprac-

tical (and probably undesirable), but extant KBS technology should be capable of incorporating most of the associated process activities (perhaps similar to the 80/20 split above).

SIMULATION RESULTS

Simulation represents a powerful computer-based capability for evaluating the relative performance of numerous alternatives in a very short amount of time, and for gauging the effects of management decision-making alternatives—such as competing process redesigns—*before* committing time and money to a particular alternative (Hansen, 1994; van Mael, 1993). This point is very important, as many BPR methodologies omit this testing step, and jump directly from process redesign into implementation of a particular technology. The simulation of redesign alternatives is generally much less time-consuming and expensive than conducting pilot projects, particularly when a relatively large number (say three or more) of alternatives is involved; further, simulation is much, much faster and cheaper than implementing an *inappropriate* redesign alternative.

Table 2 provides a summary of simulation results for the three IT-based RFP redesign alternatives. The simulated performance of each IT-based redesign alternative is projected for a period of one fiscal year, and compared with that of the RFP process baseline in terms of activity cost and cycle time. The figures shown in the table reflect the percentage *process improvement* over the baseline RFP process. For purposes of significance, a performance-doubling threshold is established for “dramatic” (i.e., 2x) improvement; that is, either cost or cycle time must be reduced by at least half (50%) to merit consideration as a process innovation. Alternatives that do not to at least double performance are better classified as CPI initiatives than as BPR transformations.

Workflow systems performance. First, notice that the workflow systems transformation effected only a modest (28%) improvement in cycle time, and had a negligible impact on process cost. Given the potential for improvement noted above, this may appear surprising, for workflow systems can greatly reduce the communication time between process activities, and provide the capability to automatically route work documents (at the right time) to the appropriate agents. These results also ran counter to the intuition of process experts and participants, as they considered this technology to have the greatest redesign potential. Through analysis, however, one discovers that workflow systems do not change the process *activities* that must be performed; rather, they change only the *environment and interface* within which the performance of such activities takes place. Such simple insertion of IT into an organizational process

has been colorfully referred to as “paving the cowpaths” and “automating the mess” (Hammer, 1990). Using a workflow interface can sometimes even impede the performance of certain tasks.

For example, using a slow, tedious, or non-intuitive interface to consult on-line regulations or other references can require more effort than simply opening a (paper-based) desk reference (e.g., the FAR). Additionally, most workflow systems are configured with the electronic equivalents of in-boxes (e.g., task lists) and

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out-boxes, as agents must deliberately “open” their tasks before processing. Therefore, although the *communication* between process activities is much faster through workflow systems, without redesigning the underlying process itself, the actual *latency* of documents awaiting processing does not necessarily improve through the technology. Moreover, implementation of IT such as a procurement workflow system requires customization, training, maintenance, and support, in addition to the associated computer and network hardware and software costs. Based on these results, the procurement workflow system does not portend the kind of dramatic performance improvement expected through process innovation—at least not as a standalone alternative, or as an end in and of itself.

Expert systems performance. The review expert systems redesign reduced

both cost (11%) and cycle time (33%) for the RFP process. Notice, however, that neither the cost nor cycle-time improvement exceeds the performance-doubling threshold. These results also appear surprising, and ran counter to the intuition of

"...the knowledge-based systems used for RFP document composition exceeded the performance doubling threshold for both cost (52%) and cycle time (67%)...."

process experts and participants; they considered this advanced technology to have excellent redesign potential, and, given the fact that the KO and legal review

tasks are *automated* through the expert systems, much greater improvements in process performance were expected.

Through analysis one discovers that, although these review tasks represent *critical* steps to ensure the quality and professionalism of RFPs, the reviews do not represent *high-leverage* activities for process redesign; in other words, the review activities are very important, but, as a percentage of the total process cost and cycle time, they do not represent the major contributors in terms of activities. Hence, only modest performance improvements can be expected to accrue through the automation of these RFP review activities.

Knowledge-based systems performance. In contrast with the modest performance improvements projected above for the workflow- and expert-systems redesign transformations, the knowledge-based systems used for RFP document composition exceeded the performance-doubling threshold for *both* cost (52%) and cycle time (67%), reflecting the kind

of dramatic gains expected through reengineering. These results were also surprising and counter-intuitive, but for very different reasons. As noted above, the composition KBS transformation represents less technological sophistication with respect to the review expert systems, yet the payoff from this redesign intervention is dramatic. This provides an interesting insight into the relationship between technological sophistication (and risk) and process improvement (i.e., payoff), and casts some doubt on a widely espoused notion that major improvements require the most advanced technologies.

Through analysis one discovers that the relative success of this redesign transformation is attributable to the high leverage associated with RFP *composition* activities. Recall that this provides a contrast to the relatively low leverage observed through the RFP *review* activities from above. Specifically, unlike the RFP review activities that are automated through the expert systems transformation—which we indicated contributes a relatively low percentage to total process cost and cycle time—the RFP composition activities constitute the bulk of process tasks required to prepare RFPs. In other words, for this particular RFP process, the contract specialist's document-composition activities offer the greatest potential for improvement in terms of automation, and the KBS technology targets these composition activities directly.

Finally, it is important to reiterate that all three of these IT-based transformations neglect the integration of other, well-established enablers of process innovation (e.g., organizational design, and human resources; see Davenport, 1993). Although a number of corresponding, non-IT trans-

formations (e.g., case manager, process teams, delegation, empowerment, incentives) were identified by KOPeR, the team of process experts did not feel as though changes to the existing procurement organizational or human-resource structure would be feasible at the time of the investigation. As noted above, concentrating solely on IT-based transformations is not recommended by current reengineering practice. However, considering that the IT-based transformations above may still be *combined* with other (i.e., non-IT) enablers at a later date, the near-term prospect for effecting the magnitude of process improvement examined through this investigation must be exciting to today's procurement manager. Have faith, because current practice also recommends against trying to do everything at once.

CONCLUSIONS AND FUTURE RESEARCH

This article has investigated the redesign of the RFP process as conducted by one well-managed Navy procurement organization. The research shows that KOPeR proved to be successful in supporting the modeling, measurement, diagnosis, and redesign of the RFP process, and simulation played a critical role in the evaluation and comparison of redesign alternatives. Without the simulation results above, for example, other procurement managers may have been tempted to implement procurement workflow systems similar to the transformation described above, without an appreciation for the expected costs and limitations of this redesign alternative. Based *solely* on the procurement workflow system, such managers can anticipate negligible overall cost

savings, and only modest improvement in cycle-time performance; hence, the prudence of this redesign decision (i.e., to implement *only* the workflow system) appears to be questionable. This result may provide useful guidance to the designers and decision makers now responsible for the DoD Standard Procurement System (SPS) development (SPS, 1996); the functionality of SPS is expected to be very similar to the procurement workflow systems described above.

This research also identified the review activities of contracting officers and legal advisors as target opportunities for automa-

tation through expert systems. KOs and lawyers represent well-paid,

highly trained professionals that are critical to the RFP process, and automating their reviews through expert-systems technology was perceived to represent an excellent opportunity for process improvement. However, even with the workflow systems infrastructure (which KOPeR indicated was a necessary condition for expert systems' efficacy), this redesign transformation failed to exceed the performance-doubling threshold for process improvement. Particularly during times of tight fiscal constraint, it may be prudent to subordinate this redesign transformation to others that reflect greater potential for dramatic performance improvement.

Specifically, the document-composition that KBS succeeded in more than halving both the cost and cycle time of the RFP process. Even though it uses less-sophisticated AI technology than the review expert sys-

"...the KBS transformation exceeded all other redesign alternatives in terms of dramatic performance improvement."

tems, the KBS transformation exceeded all other redesign alternatives in terms of dramatic performance improvement. This highlights an exciting opportunity to further explore such composition KBSs, and possibly to couple this promising KBS technology with current efforts to develop and implement the next generation of procurement workflow systems (e.g., SPS).

Further, a system such as KOPeR may itself complement current efforts to capture other acquisition processes through computer-based modeling. Because of KOPeR's measurement-driven diagnostic capability, it has the potential to run "in the background" (i.e., as a non-user-directed process) of emerging process tools such as KnowledgeWorker (Knowledge-

"Finally, acquisition does not represent a solitary activity; rather, it involves the interaction between a procuring organization and one or more contractors submitting proposals and supplying goods and services."

Worker, 1996), serving to suggest potential redesign transformations even as the basic process information is being captured and formalized through the system. Indeed, because workflow

systems themselves depend on a (computer-based) process model to function, KOPeR could also operate "behind the scenes" (i.e., outside of the users' immediate views), diagnosing pathologies and faults in the underlying workflow-enhanced processes (e.g., helping to avoid "paving the cowpaths" and "automating the messes"). This represents another interesting area for future research.

As an immediate topic of related research, recall that this present investiga-

tion is designed to produce results that are broadly generalizable. This suggests that KOPeR and the RFP redesign transformations described in this paper offer good potential to innovate the RFP and like acquisition processes in other organizations. Given the regulatory nature of defense acquisition, one would expect to see considerable similarity among the procurement processes of various naval commands (e.g., NAVAIR, NAVSEA), service components (e.g., Air Force, Army), government agencies (e.g., DOE, DOT), and major corporations. Generalizing the results of this present investigation represents an opportunity to leverage the benefits of KOPeR and knowledge-based reengineering, which could help spark AI-based acquisition process innovation on a wide scale.

Finally, acquisition does not represent a solitary activity; rather, it involves the interaction between a procuring organization and one or more contractors submitting proposals and supplying goods and services. This interaction suggests that the kind of research described in this paper can be extended, for example through investigations to integrate the government-RFP and contractor-proposal processes. Such integration could lead to the discovery of additional opportunities for dramatic performance improvement through process redesign. In the spirit of acquisition reform and integrated process teams, research along this line also has the potential to reduce *contractor* costs (and cycle times) as well as those incurred by procuring organizations directly. Clearly, much work remains to be done, but KOPeR and its IT-based process innovations appear to offer great potential.

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