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NEGOTIATING THE DIGITAL ENVIRONMENT

This chapter provides a structured approach to the development of an Acquisition Program's Digital Environment (APDE). It highlights key areas of concern and helps to identify many of the questions and issues that Program Managers (PMs) need to address. In addition, it highlights basic information required by program management offices (PMOs), where to go for help, and provides a methodology for developing a Concept of Operations (CONOPS).

The APDE

As described in Chapter 3, there are considerable potential benefits offered by an integrated information environment, or APDE.

> *The time for revolutionary change in our information practices is now. By leveraging available technology and modifying business practices to better capture the efficiencies available through the use of shared information, significant cost savings can be realized throughout the product life-cycle.*[1]

The goal of an APDE is in fact more than direct cost savings. More important are: the savings achieved as an outgrowth, or by-product, of an APDE; and the potential to decrease cycle times, increase efficiency, improve data flow and system supportability, while dramatically improving the quality and timeliness of decision making processes at all levels.

An APDE is a necessary precondition to achieving major process improvements or reengineering. But to what extent does it make sense for a given PMO to develop an integrated digital environment? The development of an APDE can be a significant undertaking and very costly in terms of time, personnel, equipment, and monetary resources. It can range in complexity from the very simple to the very complex. At the low end, key people may share e-mail and limited information sets within the PMO and/or with the prime contractor, perhaps incorporating Netscape to facilitate data access. At the high end an extensive digital infrastructure enables every active participant to have direct access to all pertinent data relating to their particular function or process, regardless of the physical location of the database. (Refer to Figure 2-8 page 2-14 for the researchers proposed APDE model.) These active participants include not only the PMO and prime contrac-

tor personnel, but also sub-contractors, vendors, suppliers, support agencies, and end users. What is right for a particular PMO is a point somewhere along this continuum. If too little is done, the Department of Defense (DoD) does not fully realize the potential benefits of the APDE. Do too much and the return on investment (ROI) is diminished, or costs may even increase. How far to go depends upon a variety of factors including:

- Type of acquisition system being developed;
- Present phase of development;
- Contractor capabilities;
- Existing processes;
- Current automation infrastructure;
- Need for information sharing;
- Physical location of various key personnel and organizations; and
- Available resources (this is foremost).

What Does the PM or PMO Need to Know

The PM must have the vision, or ability, to understand the potential for a cross functional integrated digital environment. Interviews have shown that extensive technical knowledge or detailed functional acquisition experience is clearly not a prerequisite for the success of an APDE. In fact, too much technical background or experience may result in decisions being clouded by pre-conceived ideas. The PM must understand that information itself is an asset that needs to be managed carefully over the entire life cycle of the program. Information is more than simply a gathering of data used to describe assets and actions. Information has value, it has multiple uses and purposes, and it supports everything relating to the acquisition program. Properly managed, information can save time, increase efficiency, improve system quality and performance, and reduce cost. The APDE enables this effective management of information and information processes.

Gain Access to the Right Tools

In most PMOs interviewed, there existed a general lack of experience and knowledge with respect to the potential, requirements, capabilities, and limitations of an integrated digital environment. DoD acquisition personnel, and many industry managers for that matter, do not feel adequately prepared to develop an APDE infrastructure. The general sentiment from several interviewees was that "we don't even know enough to ask the right questions, let alone come up with the answers." It is important for the PMO to be able to access information and personnel that can help them negotiate an APDE development effort. The PM needs individuals with an understanding of APDE related areas such as: available technology; network support and network security; communications requirements and capabilities; data rights and access restrictions; contractor integrated technical information service (CITIS); computer-aided design/computer-aided manufacturing (CAD/CAM); Continuous Acquisition and Life-cycle Support (CALS); electronic commerce/electronic data interchange (EC/EDI); national and international standards; and lessons learned from other PMO initiatives. In many cases the information and assets are not found within the PMO. Training programs, other DoD agencies and PMOs, consultants, outside research, and contractors should be used extensively to support the APDE development process.

The PM Must Be Involved: APDE ≠ Logistics

The DoD strategy for an integrated data environment (IDE) is being developed by the DoD CALS office. Although CALS officially encompasses the entire "lust-to-dust" life cycle of a program, the effort is run by the logistics community and has historically had a logistics focus.[2] As a result, there is a tendency by materiel acquisition and program management to relegate IDE and CALS issues to their senior logistics personnel. This is a mistake. The PM must understand that the APDE, an acquisition program's functional equivalent to the IDE, potentially interconnects all program processes to become an indispensable tool for the PM. The APDE impacts all stakeholders to include:

- Entire PMO;
- Industry partners: contractors, manufacturers, integrators, and vendors;
- Coordinating agencies such as contracting and finance;
- Support agencies such as maintenance and sustainment activities; and
- Ultimate end users.

Not only are stakeholders impacted, but an APDE also impacts areas critical to a program's success:

- Acquisition management;
- Financial management;
- Procurement planning and contract management;
- Engineering management;
- Logistics management;
- Test and evaluation; and
- Production management.[3]

While much credit appropriately goes to the logistics community that is attempting to develop an environment that supports this integration effort, making it happen is an acquisition PM's responsibility. The logistics community or the senior logistician within a PMO does not have the training, the experience, the responsibility, or the program authority to bring all these various functions, activities, and processes together. That is the job of the PM, the PMO staff, and their industry partners.

Contractor Involvement

The cooperation of, and coordination with, the prime contractor is perhaps the most important ingredient to a successful APDE implementation. While this may seem obvious, there is often a "we-they" relationship between PMOs and contractors that detracts from the effective development of an integrated digital environment. The PM must try to overcome this potential barrier and work toward a true partnership with industry. While the government's goal is a quality product for a fair price, the contractor's goals include a fair profit for the work they perform. Perhaps the real solution is attainment of both sets of goals.

An APDE offers a unique opportunity for a total win-win situation, providing significant cost savings and other programmatic benefits to both government and industry participants. The new DoD Regulation 5000.2-R, dated March 15, 1996, cites that "award programs (both monetary and non-monetary) and 'shared savings' programs shall be used creatively to encourage the generation of cost-saving ideas for

all phases of life cycle costs."[4] The PMO and associated contractors must jointly identify and develop a strategy that (a) supports the objectives of a truly integrated digital environment, and (b) works to the mutual benefit of all concerned. Ideally, the APDE is a digital partnership between government and industry which is cross functional in nature and extends beyond a CITIS environment to support the full life cycle of a program.

Getting to this point may not make good business sense in some programs, but that decision should not be made until a complete analysis of the situation, costs, and benefits have been made by both the PMO and its industry partners. Understanding all parties' goals, objectives, incentives, and concerns of the others is important. In some cases simply involving contractors in the process and enabling them to introduce ideas that are of mutual benefit is sufficient to promote action. As PM Combat Mobility Systems (CMS) cited:

> *The PM, CMS IDE effort has had the positive effect of incentivizing their prime contractors, [names omitted], to accelerate internal initiatives to improve operational efficiency. The requirement to eliminate paper deliverables has allowed each contractor to bring automated solutions to the table, thus enhancing the overall IDE effort. While under no obligation to do so, each prime contractor has taken an active role in the establishment of IDE capabilities within their own corporations and improving those with the TACOM [Tank and Automotive Command] community.*[5]

Simply the government's willingness to reconsider outdated ways of doing business and move toward an APDE approach may well be sufficient to spur suggestions, ideas, and actions on the part of the contractor, and from within the PMO.

Today, all major contractors are producing documents, program data, and technical drawings in digital form, while exploring digital environments to some extent. Many organizations interviewed state emphatically that integrating processes internally through a digital infrastructure makes sound business sense and is an essential core competency needed to remain highly competitive. Extending that environment down to suppliers, support chains, and customers (i.e., the PMO), enhances their ability to do business faster, smarter, cheaper. In some cases, contractors even provide both the hardware and software infrastructure to their sub-contractor chain, because even with the added overhead expense it enables them to reduce overall costs and increase efficiency.[6] The point to be made here is the PM should not presuppose that, in order to benefit from an APDE, the PMO must necessarily bear the full cost. The mutual advantages may be sufficient to incentivize industry to share the burden in both the design and implementation. In order for this to occur, they must be true partners—both actively involved in the process.

Where to Go for Information

This section identifies some of the primary sources of information the PM can use to answer the many questions that invariably arise. The PM has significant latitude in determining the method(s) and degree of APDE implementation, and requires an extensive amount of information in order to make an informed decision. Unfortunately, personal interviews and research find there is no single office or organization capable of providing comprehensive information on APDE implementation, as it pertains to the PM's potential requirements. As technology is constantly evolving and there

is no "one size fits all" solution to an APDE, it is incumbent upon the PMO to seek out various alternatives and resources in order to identify the solution that best meets a program's needs.

Surf the Net

Perhaps one of the most useful resources available to any manager today is the Internet. In this project, the Internet allowed us to quickly locate, identify, and communicate with numerous individuals and organizations involved in efforts relating to the subject material. The proliferation of home pages and available on-line reference material, particularly within DoD, provides almost immediate access to updated information on agencies, programs, projects, and actions throughout the world. It supports not only finding previously unknown sources of information, but also permits the user to quickly filter out those organizations and efforts that are of little relevance. While not a panacea, the Internet is a truly viable and useful resource. For the PMO involved in exploiting the digital environment, reviewing information available on the World Wide Web (WWW or the Web) is a must. Possible search criteria might include:

- Acquisition Reform;
- CALS;
- EC/EDI;
- Defense Information Systems Agency (DISA);
- National Institute of Standards and Technology (NIST);
- Electronic Commerce Resource Center (ECRC);
- Lead AMC Integration Support Office (LAISO);
- Joint Computer-aided Acquisition and Logistics Support (JCALS);
- Joint Engineering Data Management and Information Control System (JEDMICS); and
- Department of Commerce (DoC).

Government Efforts

There are various organizations within DoD and the federal government that are involved in the exploitation of digital environments. These include the logistics community, the acquisition reform community, the contracting community, DISA, DoC, and others. It would be beneficial to the PMO to at least have a general understanding of what each of these organizations is doing, how it can potentially impact the PMO's APDE, and what value- added they might be able to offer. In some cases ongoing efforts can have a direct impact on the PMO by providing possible funding resources, technical solutions, or lessons learned.

Funding

A significant advantage to seeking out DoD and other government initiatives is the potential for funding or solutions that incur little or no cost to the PM. There are numerous ongoing pilot and/or demonstration programs. One major PMO received in excess of $5 million from different agencies to fund IDE hardware, software, and infrastructure maintenance as a part of a DoD pilot effort. Other organizations have also received either funding or direct support (hardware, software, consulting, etc.) as part of technology demonstration programs.

The dynamic nature of digital information technology lends itself to the need for testing, demonstrating and validating concepts, and innovative solutions. PMOs willing to participate in such programs, which work to the mutual benefit of the PM and the sponsoring agency, can often take advantage of resources made available by the organization involved in the development effort. Programs like the Industrial Modernization Incentive Program (IMIP), Manufacturing Technology (MANTECH), Value Engineering (VE) program, Independent Research And Development (IRAD) program, and other incentive contracts are possible sources of funding.[7] Additionally, non-DoD sources such as DoC, joint government funding, and state government programs might also be areas to explore. Some of the DoC funded programs included under NIST are: "Cooperative R&D Agreements (CRADA–where companies form partnership agreements with the government), Manufacturing Technology Centers (MTC–that facilitate the development and implementation of manufacturing technology for small businesses), and High Performance Computing & Communications (HPCC–focusing on U.S. initiatives for providing key information services through a National Information Infrastructure (NII))."[8] Joint government funding programs, such as those through Advanced Research Projects Agency (ARPA) and the Technology Reinvestment Project (TRP), might also be applicable, but are largely contingent upon cost sharing agreements between government and industry.[9]

Government Standardization Efforts

The PM needs to examine government development initiatives and pilot programs to determine their applicability to specific programs and the degree to which they relate to the proposed APDE implementation. This is important if the data user community will be employing government solutions. Government off-the-shelf (GOTS) development efforts such as JCALS, JEDMICS, and Configuration Management Information System (CMIS) should at least be considered, particularly as they apply to future maintenance and sustainment functions. Evolving Acquisition Reform (EC/EDI) efforts supporting business processes within DoD may also be applicable. When considering such alternatives, interoperability issues across the total life cycle, within a future DoD-wide digital infrastructure, should be well understood and addressed.

Commercial Developments

The digital environment, and the technology supporting APDE implementations, is evolving at a rapid rate. Commercial products and services within the business community provide numerous functional capabilities desired in an APDE. In some cases these are stand alone applications, and in others they are well integrated environments that support cross functional and process integration. The latter includes CAD/CAM systems, workflow managers, integrated cost-scheduling-management packages, data access and security software, and various intra-net applications. Most of the PMOs and contractors visited indicate that both the PM and the contractor need to at least be cognizant of what is ongoing in the commercial world in order to evaluate the potential benefits. They must also continue to follow evolving technology. From a PM's perspective, this may be beyond the expertise of people within the PMO, but such a study/evaluation might well be worth having the prime contractor or a capable support contractor perform.

Talk to Other PMOs

Learn from the experience and efforts of others. Research interviews reveal that, even

where substantial APDE efforts are underway, there is normally little sharing of information between PMOs on issues relating to the approach to a digital environment, problems encountered, technical solutions, or lessons learned. In many cases PMOs largely consider themselves "operating in a vacuum and inventing a system from scratch." Seeking out PMOs with similar operating environments and taking advantage of their experiences, both good and bad, is the PMs responsibility. The Services, DoD CALS, and EC/EDI offices should be consulted to identify possible points of contact. This is particularly appropriate where different PMOs are working with the same prime contractor. In several instances research shows a prime contractor independently developed different APDE and CITIS implementation environments for different DoD customers. The PMOs could have avoided duplication of development effort and support infrastructures, but were either unwilling to do so or were unaware of the ongoing parallel efforts. Even the contractor agreed that they could have been much more efficient and conceivably developed a more comprehensive integrated environment had the PMOs been interested in consolidating requirements. While many issues within a PMO are program specific, the PM should constantly be open to new ways of doing business and guard against the "not invented here" syndrome.

Who Needs to Be Involved

The application of digital technologies to government acquisition should be seen as a way to improve and streamline all processes by providing better methods of creating, managing, and using data; not as a method of simply automating existing business practices.[10] The entire organization, especially principle contractors and functional experts, need to be involved in identifying current APDE requirements and its potential to meet future needs. This is not to say that decisions are made by committee; they are not. Input should be solicited from many, but a select group of individuals need to be identified to spearhead the effort. In the past, a government team has been expected to develop the program requirements for an IDE. However, research discussions find that by far the most productive approaches are those that involve the contractor early in requirements development process, and actively during analysis and implementation. The contractor typically has substantial experience, a better understanding of the technology, and a clear vested interest in the success of the program.

This APDE development group, essentially an integrated product and process development (IPPD) team, should be chosen carefully, not only based upon experience and knowledge of the system, but also on objectivity and innovativeness. They need to understand how the system works and, more importantly, what makes sense when it comes to determining how the future system should work. The goal is to improve processes, not necessarily improve given functions that relate to a process. This is the key to reengineering, or at least achieving substantive process improvement. An APDE development effort, particularly in the early stages, must try to avoid focusing on turf protection, job protection, pet projects, and potentially outdated ways of conducting business. If those leading the effort cannot be totally open to new ideas and change, perhaps they should not be leading the effort.

Define and Question the "As-Is" Infrastructure /Processes

Each PMO must first identify, and be able to articulate, the existing "As-Is" infrastructure before initiating a plan to develop an APDE CONOPS. No one can develop a road map for

where they want to be unless they first understand where they are. The APDE offers significant opportunities for process improvements and, potentially, reengineering. But this is only possible if the organization understands how it currently does business. The PMO, in conjunction with its prime contractor(s), associated support agencies, and other data users, should attempt to identify:

(a) what is being performed;

(b) how is it being performed;

(c) what is the value-added at each step/phase;

(d) what processes are being supported;

(e) what are the data requirements
- what data are required in the process,
- who in the process needs the data,
- what is done with the data,
- what data/information are provided to the end user; and

(f) why is it being performed in this manner.

It has been said that an IDE, or essentially an APDE, "represents a true departure from the tyranny of "As-Is" systems and data structures."[11] While this may sound dramatic, it does have some merit. Current systems developed as a result of a hierarchical paper-based architecture stem from what has been characterized as the industrial age. Such systems dictate a relatively slow serial flow of information between functional areas with limited flexibility. An APDE enables the PM to restructure the organization around processes, as opposed to around organizational and functional requirements that developed by necessity from the rigid structure of a paper-based acquisition environment. Once the "As-Is" infrastructure is identified, the next step is to evaluate what events, data requirements, and functional processes actually provide value-added. Is each and every step necessary? What is the purpose behind each step? Is there a better way?

APDE CONOPS

The IDE infrastructure has been defined and articulated in the past through a document entitled the *Government Concept of Operations (GCO)*, which reflects government information and data requirements. While the approach is generally the same, within this research effort the term APDE CONOPS has been selected. This is to emphasize the findings that the CONOPS must be, in effect, a joint government-contractor initiative and should reflect a strong partnership between the PMO, industry, and all associated data users. Inclusion of industry requirements reflects the teaming effort required for a truly integrated APDE, and reduces unnecessary duplication of effort on the contractor side. Government requirements should extend beyond the PMO. Care is needed to also address the requirements and needs of support agencies, the logistics community, and the system's end user. The examination of data requirements should not mirror the As-Is infrastructure, but provide a road map to a "To-Be" architecture enabled by the APDE.[12]

The APDE CONOPS articulates the "To-Be" vision for the organization or program; identifies the APDE requirements; provides high-level implementation planning guidance; describes the functional architecture; articulates critical success factors; and establishes milestone schedules for project completion.[13] The CONOPS becomes the de facto standard by which APDE implementations and enhancements are measured. Even when completed, the APDE CONOPS remains a living document.

As the APDE implementation progresses, or as changes occur to the acquisition program or its data requirements, the CONOPS guidance must be revisited and changed as necessary. Regular updates to the CONOPS are recommended as the system matures and the concepts and technologies continue to develop.[14] A methodical approach to the development of an APDE CONOPS is provided below. Supplemental information, along with a sample GCO for a new acquisition program, can be found in MIL-HDBK-59B and the *PM's Digital Desktop Guide* produced by the DoD CALS office.[15]

APDE CONOPS Development Process[16]

Figure 5-1[17] depicts a suggested process for developing an APDE CONOPS. Even in the absence of an aggressive APDE effort, this approach provides a mechanism for the PM, the staff, industry partners, and additional stakeholders to evaluate the use of data and information across the life cycle of the program. It helps to identify and highlight the:

- Adequacy (and redundancy) of data requirements;
- Common data/information requirements and uses;
- User requirements (data, hardware, software, additional capabilities);
- Physical infrastructure capabilities and limitations;
- Interoperability and compatibility issues;
- Potential objectives of the APDE (where we would like to be);
- Mechanism for enabling process improvement / reengineering;
- Framework for cost-benefit analysis; and
- Means to articulate a road map for APDE implementation.

Identify What Types of Data Are Required

Data type deliverables are the data requirements specified on the Contract Data Requirements List (CDRL) for the program. Typically they are categorized by program function, but in an integrated environment individual data elements should be viewed as commodities with multiple potential uses. This life cycle view of data, corresponding to the idea of "create once, use many times," ensures not only that the necessary data are available, but that it is accessible in a form acceptable to all functional users. Table 5-1[18] provides a list of sample data types that may be digitally developed, accessed or delivered, indexed, and maintained. This Table is not intended to be all inclusive.

Identify Who Will Use the Data

Data users are normally the functional organizations that will require access to the program data. Within the PMO they include as a minimum: management, engineering/design, supply, training, manufacturing, and maintenance. Contracting offices, civilian contractors, suppliers, vendors, logistics support, DoD coordinating agencies, and system users also require data access.

Identify What the User Will Do With the Data

The PM needs to identify the data use requirements of the various functional users. Data use requirements are the ways in which chosen data types are expected to be processed. The five methods of data processing typical of most defense systems include:

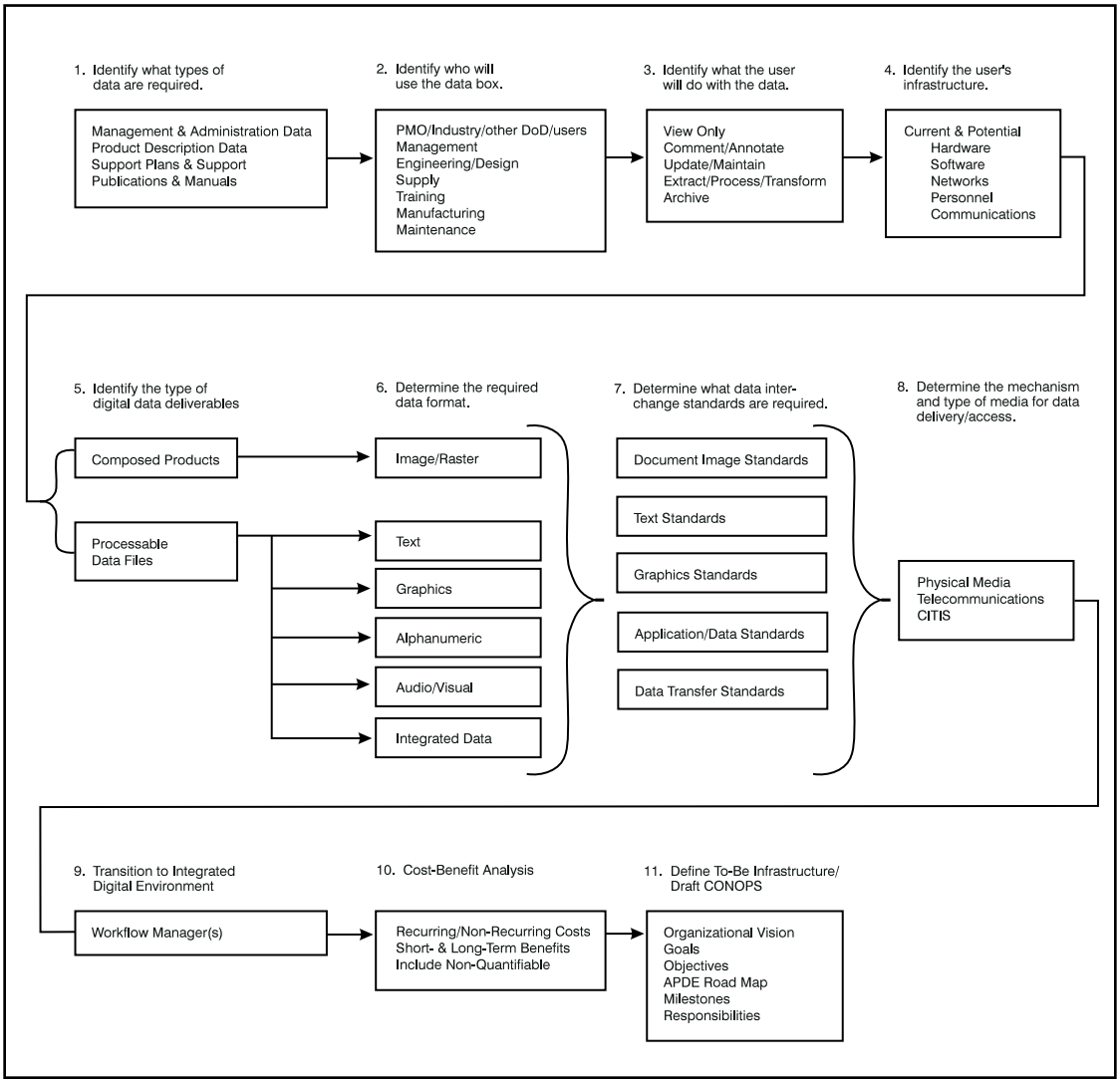

Figure 5-1. APDE CONOPS Development Process

- View Only – examine files without the ability to change it;
- Comment/Annotate – highlight, approve, add notations;
- Update/Maintain – change, add, or modify data;
- Extract/Process/Transform – extract and modify the format, composition, and structure of the data; create standard and custom documents through the extraction and manipulation of data from a variety of sources; and
- Archive – index, store, and preserve data for future use.

MANAGEMENT AND ADMINISTRATION DATA	PRODUCT DESCRIPTION DATA (Continued)
Program Plans	System Engineering Analysis Report
Program Schedules/Master Schedule	Engineering Data
Engineering Support Plans	
Progress and Status Reports	**ILS/LSA PLANS AND REPORTS**
Contractual Vehicles	Integrated Logistics Support Plan (ILSP)
Conference Agendas/Minutes	Logistics Support Analysis Plan (LSAP)
Reviews and Audits Documents	Logistics Support Analysis Record (LSAR)
Technical Data Identification Checklists	Safety Assessment Reports
Standardization Program Plan	Reliability Assessment Reports
Contract Work Breakdown Structure (WBS)	Maintainability Reports
Cost Performance Report	Hazardous Materials/Process Reports
Management Information System (MIS) Plan	LSA Tasks (MIL-STD-1388-1)
Config. Audit Plan/Status Accounting Report	Maintenance Plan/Reliability Plan
Data Accession List	Maintainability Plan
Configuration Management Plan	Level of Repair Analysis (LORA)
System Engineering Management Plan (SEMP)	Test and Evaluation Master Plan
CALS Implementation Plan (CALSIP)	Test Reports
	Life-Cycle Cost Estimates
PRODUCT DESCRIPTION DATA	Manufacturing Plan
Technical Data Package	Environmental Impact Report
System Specifications	Technical Report-Study Services
Engineering Drawings and Associated Lists	Quality Program Plan
Analysis Data	Computer Resources Integrated Support Document
Simulation Data	Design to Cost Plan
Test Data	
ECP, RFW, and RFD	**PUBLICATIONS**
Product Specification	Technical Publications
Software Development Plan	Technical Manuals
Software Test Plan/Description/Report	User's Manuals
System Specification Report	Operations Manuals

Source: MIL HDBK 59B

Table 5-1
Typical Data Type Deliverables

Identify the User's Data Infrastructure

The generation of digital data is of little value if it does not meet the user's requirements. In addition to understanding what data the user needs, and how it will be employed, it is also important to address the user's operating environment. Current and projected capabilities of the entire data user infrastructure, the computing environment available to the user community, must addressed. This includes:

- Hardware;
- Software;
- Networks;
- CITIS;
- Computer support personnel; and
- Communications.

Care is necessary to ensure the compatibility between data, data requirements, and the users' infrastructure. If the APDE is to work, it is important that the users' data requirements, to include how users will actually process and use the data, are supported. Developing a comprehensive infrastructure between the PMO and the prime contractor may achieve limited overall benefit if requirements of key external data users (i.e., support community, sub-contractors, or product end users) are not met. In some cases the best employment of resources to exploit a digital environment may, in fact, be to improve the data infrastructure of data users outside the PMO.

Identify the Type of Digital Data Deliverables

The following are types of digital deliverables supported by an electronic environment:

Composed Products: Human interpretable documents that typically do not support further processing since they are complete, standalone entities. Essentially the digital equivalent to a paper document, they typically contain no embedded digital links or connection to external data or program information (i.e. published reports, scanned drawings/plans, charts and graphs).

Processable Data Files: Machine readable dynamic information that includes accessible source data from multiple data applications. This enables the user to create standard and custom documents through the extraction and manipulation of data from a variety of sources. A simple example is a monthly status report that extracts action, schedule, completion, and cost information from various data sources to construct a single user friendly chart or graphic. The generation of technical manuals (TM) can also receive support through processable data files: figures can be extracted from engineering drawings; system descriptions from configuration management data; maintenance information is linked to current depot support; component re-ordering information is derived from a logistics database; and the TM can be quickly updated with each iteration or revision.

Determine the Required Data Format

Data can be procured in several forms:

- Document image file;
- Text file;
- Graphics file;
- Alphanumeric file;
- Audio/visual file; and

- Integrated data file.

The data required, and the manner in which the user will utilize the data, dictate the recommended data format. Note that how the data are used today in the "As-Is" environment may be significantly different from future "To-Be" requirements and formats. In some cases, such as legacy data, cost restrictions may preclude making the data available in other than Raster or page description language (PDL).

Determine What Data Interchange Standards Are Required

In order to ensure the proper sharing and exchanging of information across dissimilar systems, the PM must consider the possible loss of information when translating between software applications or from one data format to another (whether the format is standard or not). The following types of interchange standards are used with data formats listed above:

- Document image standards;
- Text standards;
- Graphics standards;
- Application unique/data standards; and
- Data transfer standards (i.e., e-mail and e-mail attachments).

The manner in which data will be utilized (manipulated, presented, and exchanged) impacts the acceptable set of data formats. Chapter 6 discusses the use of standard formats which do not always guarantee interoperability. Standards typically require a minimum set of compliance requirements, but permit additional capabilities. If all systems do not support the full range of capabilities, interoperability and file compatibility suffer. A simple, yet often experienced, problem involves text and graphics standards. MS-Word and WordPerfect files are compatible in that a document created in one can be read and manipulated by the other. However, if one user's document includes graphics, images, and/or tables, file exchange becomes much more complex. Often within an APDE implementation it is not only important to ensure that everyone has access to a given set of hardware/software applications and interchange standards, but that the manner in which the applications are used is consistent with interoperability and file compatibility across the infrastructure (to include users outside the PMO).

Determine the Mechanisms and Type of Media for Data Delivery/Access

Current acquisition guidance supports on-line access to, or delivery of, programmatic and technical data in digital form.[19] The PM needs to determine the data delivery/access media or mechanism requirements and ensure those requirements are specified through the statement of work (SOW), the CDRL, and specific Data Item Descriptions (DID).

Physical Media:

Magnetic tape is a mature, stable technology that is able to handle the large volumes of data typically associated with a major defense system acquisition. Magnetic tape standards are well defined, and little additional investment cost will be involved. However, other media may be more efficient and, therefore, preferred.

Magnetic disk is also widely implemented on personal computers and work stations and may be the physical medium of choice for small business contractors. Several primary

de facto magnetic disk formats are available but no official standard has been accepted. Compatibility problems exist, but can be overcome with only moderate effort.

Optical media is used here as a generic term to include Compact Disk-Read Only Memory (CD-ROM), Compact Disk Interactive (CDI) and Digital Video Interactive (DVI), Write Once and Read Many Times (WORM), and erasable optical disk. These media are ideal for mass distribution and archival purposes for large volumes of data.

Telecommunications:

Telecommunication networks provide an excellent opportunity to deliver, access, and exchange information. On-line delivery may be achieved via two methods: (1) delivery of CDRL items from a contractor sending system to a government receiving system via telecommunications download; or (2) in-place delivery, which allows data items to be stored and maintained at a contractor's site for retrieval and display via telecommunications using a government terminal, personal computer, or workstation. Secure, on-line transmission or delivery of the full volume of data for defense systems is technically feasible but often severely taxes telecommunication networks. On-line access, as distinguished from on-line delivery, refers to the situation in which an organization accesses data items through CITIS, or other similar information management services, as negotiated in the contract. On-line interactive access provides immediate and timely data access for custom report generation, document generation, and on-line request of information transmitted as composed products and processable data files.

Contractor Integrated Technical Information Service (CITIS):

A CITIS can be the backbone of a PMO's APDE, providing significant benefits to the PM. A CITIS clearly supports the spirit of emerging acquisition regulations and directives, including the DoD 5000.2-R goal of employing the "concept of Integrated Product and Process Development (IPPD) throughout the program design process to the maximum extent practicable."[20] While this goal specifically addresses the key tenet of IPPD as being Integrated Product Teams (IPTs), the CITIS provides the set of core information functions to facilitate the concept of "shared data" which is critical to IPT success. CITIS exemplifies the APDE and IDE vision of creating data once and using it many times and standardizes functional characteristics of the data to facilitate its usage by a wide variety of different users.[21] While an APDE implementation can exist without CITIS, it would be very limited in scope.

A variety of factors can influence the decision for a CITIS requirement, including program phase, data type and format, volume of data being delivered, lifetime of the data, the interchange standards required, and the cost to implement the system.[22] PMs need to understand the CITIS data infrastructure options being offered by their contractor(s) and examine the degree to which they support the PMO. Use of existing information systems and data formats [e.g., CITIS] is preferred over a government unique solution, providing it is compatible with operational DoD information systems and data.[23] A CITIS can play a key, if not essential, role in the success of the APDE, and meeting user's information requirements. Government access to data is of little value if the

manner in which the data are accessed, the ease and timeliness of access, the format of the data, and the systems supporting the use of the data, do not satisfy the user's needs. The *Military Standard, Contractor Integrated Technical Information Service (CITIS) 974 (MIL-STD-974)*, dated 20 August 1993, addresses CITIS functions which may be specified in the SOW and listed as contract line items.

Workflow Manager:

Data access, compatibility, interoperability, and system connectivity provide a basic framework with enormous potential. However, the To-Be infrastructure described by the APDE CONOPS must also address how information is processed, used, and shared. Simply making information more accessible and automating existing processes will not result in substantive benefits. Workflow managers enable the transformation from a common data environment to a true integrated process environment by providing the tool(s) to support real process improvement and reengineering efforts. Care needs to be taken to ensure that workflow managers planned within the APDE accurately reflect not only individual user data requirements, but also the process requirements of the Government/industry team as they will exist in the future.

Cost-Benefit Analysis

An APDE requires substantial resources to create and support. The amount of resources required increases with added complexity and capability. A cost-benefit analysis assists in determining the degree to which an APDE should be implemented. In some cases the implementation may appear severely constrained due to lack of resources. However, one may also find that the accumulated short- and long-term benefits of a digital infrastructure may more than compensate for the initial expense and operating costs. In any case, the effectiveness of the "To-Be" infrastructure, and the success of its implementation, depends upon the availability and commitment of resources by the PMO. A good plan that is not adequately supported in terms of time, management, personnel, and funding will not succeed. As a result, it is important to fully analyze all costs and benefits. This section is not meant to be all inclusive, but will serve to highlight areas that need addressing.

Identify the Costs:

These include both non-recurring and recurring costs listed below:

Non-Recurring (One Time) Costs:

Physical infrastructure—Changes necessary to support the APDE include physical remodeling, furniture, and increasing communications capabilities (additional phone lines, wiring, internal network installation, etc.).

Hardware—

Computers – individual, servers, data storage, etc.

Monitors – in many cases, standard 15-inch Super Video Graphics Array (SVGA) monitors are less than optimal or not sufficient to meet user requirements. Full page documents, or technical drawings, must often be readable on-screen. If they are not, the user resorts to printing, which negates some of the advantages of a digital environment. This is typi-

cally true of technical drawings. In several cases research shows the PMO and contractors have identified that, based upon user requirements, the added expense of larger and higher quality monitors is well justified.

Printers/plotters – moving to a digital environment does not eliminate the need for paper. The ability to go from soft-copy to hard-copy is important. One concern is that offices with a hard-copy capability will "print everything anyway." However, research finds this is not the case. Organizations with adequate hard-copy capability tend to be more receptive to working in a digital environment, feeling secure that a hard-copy is always available when necessary. Organizations with limited printing capability tend to be more inclined to request and use paper (and the trusted copier). In addition to examining the need for hard-copy devices, output format size, resolution, memory, and color requirements need addressing.

Network connectivity – this includes connections, network cards, installation of a LAN, WAN, or other network environment. It also includes the purchase of modems or other network communications devices.

Software – Includes the acquisition of commercial and government software that promotes functional capabilities, data management (storage, access, retrieval, maintenance, etc.), interoperability, and systems integration.

Data Conversion – Conversion of data from existing legacy form/format to something that is useful in the "To-Be" environment. The PM needs to carefully identify exactly what data requires conversion, the type of conversion that is necessary and useful, and the most cost effective way to make it happen.

Personnel – Initial education and training will be required and should be planned for. In some cases the organization may change substantially, requiring specific individuals or skill sets to be added. As processes or functions change or become more efficient, various personnel requirements linked to the As-Is infrastructure may no longer be required. Associated personnel costs should be identified.

Recurring Costs:

Hardware/software – There is a continuing requirement for maintenance and upgrades, such as site licenses, user fees, and support contracts. Several interviewees stressed that the APDE should not and cannot be static. Planned upgrade or replacement of hardware every 2-3 years and software every 18 months needs consideration.

Communications – Monthly fees for digital links (i.e., ISDN, T-1), long-distance services, and dedicated lines.

CITIS – Access fees, support, and maintenance requirements

External services – As with any infrastructure, reliability and effective maintenance are essential. System administrators, help-desks, and other user support services may be needed.

Personnel – Training, cross-training, and skill development, are ongoing requirements. This is particularly true in a dynamic digital environment where people change, hardware and software capabilities evolve, and processes improve.

Benefits:

An APDE can provide enabling capabilities that support substantial cost savings, cycle time reduction and management efficiencies. Chapters 3 and 4 highlight these benefits. Within DoD there are few available metrics and/or incentive programs that offer definitive benefits. Chapter 6 delves into this issue. However, while it is difficult to accurately quantify the benefits of an APDE in terms of dollars, the PM needs to examine its potential value in terms of quality and productivity. In some cases the issue is not the benefits that can be attained through an APDE, but the potential increased life cycle costs if an APDE implementation is not undertaken. With budgets becoming increasingly constrained, exploiting the advantages of an APDE becomes a significant requirement if the program is to even survive.

Define the "To-Be" Infrastructure

Prior to implementing an APDE, it is critical that the PMO clearly articulate the "To-Be" infrastructure and lay out the road map for the transition. In a military environment, a clear articulation of the "Commander's Intent," or vision, is perhaps the most critical component of a mission order. This is also true when accomplishing objectives within an organizational structure, and especially the case when evoking significant organizational and process change which occurs as a PMO moves toward an APDE. Research shows the ease of implementation increases dramatically when individuals at every level of the organizations have a clear understanding of the goals, objectives, implementation plan, schedule, and the "To-Be" organization. This not only reduces cultural resistance within the organization, but also improves awareness and cooperation between management, system developers, contractors, and users. Data clearly validate that the most effective mechanism in communicating the APDE vision is through the early development of a document resembling the APDE CONOPS[24] or its industry equivalent, and the broad dissemination of its contents. The CONOPS should clearly define the "To-Be" infrastructure, its goals, and how the organization will get from where they are to where they are going.

Leading Organizational Change

The PM is responsible for addressing the questions and concerns of those within the PMO that relate to APDE implementation. Cultural resistance to change is a most difficult challenge. As the PMO moves toward an integrated digital environment, significant opportunities arise for process improvement and functional reorganization. Change is inevitable—it reduces comfort levels throughout the organization and often elicits a backlash of resentment and resistance. "That's the way we've always done it" is difficult to overcome in most organizations, particularly for those well indoctrinated in a relatively stable system that is familiar and offers physical, emotional and employment security.

Management Buy-in

The PM, industry, and government agency counterparts must gain buy-in throughout their respective organizations. This includes those internal to the organization, external people with relationships to the organization (government and contractors), remote support activi-

ties, and other users. Failure to do so impairs the APDE effort. Smooth change can only be accomplished when top level and front line employees are committed to the initiative. Top level employees typically demonstrate their commitment by being visibly involved.[25] Demonstrating commitment at all levels of management is a key success factor.

Keep Everyone Informed

The APDE effort needs to be understood to be accepted. Not only does this reduce cultural resistance, but it also promotes employee involvement and commitment even at the lowest levels, leading to significant, previously unplanned, improvements. "It is important for those who will be affected by the implementation [of the APDE] and the resulting process improvement to understand how the effort will unfold and how it will affect them as individuals."[26] While the APDE CONOPS tends to provide a top-level view, management needs to articulate how the APDE impacts individual processes and users. Are jobs at stake? How will this effect the way I do business? Exactly why are we doing this? Where are the benefits? These types of questions need answering. The PM must make people fully aware of the vision and its goals, get them actively involved in the process, increase commitment at all levels, and promote the generation of new ideas that might otherwise be overlooked. One method that has been used is to conduct workshops prior to and during implementation to open new lines of communications. This helps to identify barriers, promotes user buy-in, and enhances the planning process.[27]

Follow Through

The development and success of an APDE requires continued commitment on the part of program leadership and management throughout the data user community. The timeline, resource, training, and infrastructure requirements outlined in the APDE CONOPS requires continually monitoring to ensure initial planning assumptions are accurate, sufficient resources are being committed, and the goals and objectives are being met.

Summary

This chapter examined the development of an APDE from a PM's perspective. A detailed description is provided for developing an APDE CONOPS, which is perhaps the most critical part of the process. The CONOPS provides the framework for the APDE effort; a road map for implementation; and addresses the acquisition program goals and objectives. It examines user and process data requirements, and describes how those requirements will be met. The APDE CONOPS clearly articulates the overall vision, and thereby enables everyone involved in the process to better understand and support the effort.

ENDNOTES:

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5. Combat Mobility Systems (CMS). (March 1996). Interim lessons learned for PM, CMS IDE implementation. Unpublished paper submitted for this research report by the CMS PMO, p 4. Warren, MI: Author.

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12. Department of Defense. (June 10, 1994). Military Handbook, MIL-HDBK-59B, continuous acquisition and life-cycle support (CALS) implementation guide. Chapter 4. Washington, D.C.: Author.

13. Combat Mobility Systems (CMS). (March 1996). Interim lessons learned for PM, CMS IDE implementation. Unpublished paper submitted for this research report by the CMS PMO, p 3, 15. Warren, MI: Author.

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16. DoD CALS Office. (September 29, 1995). Program manager's desktop guide for continuous acquisition and life-cycle support (CALS) implementation, Chapter 5. Washington, D.C.: Author.

17. Figure derived in part from DoD CALS Office Program manager's desktop guide for continuous acquisition and life-cycle support (CALS) implementation, Figure 5-2 (September 1995); and from the Military Handbook, MIL-HDBK-59B, Continuous acquisition and life-cycle support (CALS) implementation guide Figure 4. (June 10, 1994).

18. Table found in the Military Handbook, MIL-HDBK-59B, continuous acquisition and life-cycle support (CALS) implementation guide, p 13. (June 10, 1994). Washington, D.C.: Author.

19. Office of the Secretary of Defense. (March 15, 1996). Department of Defense Regulation 5000.2-R, mandatory procedures for major defense acquisition programs (MDAPs) and major automated information system (MAIS) acquisition programs, paragraph 3.3.4.5. Washington, D.C.: Author.

20. Ibid., section 3.3.4.2.

21. DoD CALS Office. (September 29, 1995). Program manager's desktop guide for continuous acquisition and life-cycle support (CALS) implementation, p 171. Washington, D.C.: Author.

22. Ibid.

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24. Combat Mobility Systems (CMS). (March 1996). Interim lessons learned for PM, CMS IDE implementation. Unpublished paper submitted for this research report by the CMS PMO, p 3. Warren, MI: Author.

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26. Ibid., p 15.

27. Ibid., p 15.