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Object-Oriented Technologies in the Federal Market

1993

Federal Market Analysis Program

OCTOBER 1993

OBJECT-ORIENTED TECHNOLOGIES IN THE FEDERAL MARKET: 1993

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Abstract

This report contains a review of object-oriented technology in the federal sector. The report provides a survey of the present usage of object-oriented technology and presents a view of its future demand.

The use of object-oriented technology as a systems development concept is just beginning to have an impact in today's technology marketplace. The principal productivity benefits ascribed to the technology are reductions in development and maintenance effort for object-oriented applications. Such reductions are made possible through substantially increased reusable code and the modularity and encapsulation of both the process and data required to perform specific functions. Modularity minimizes the impact of future changes and the required testing and integration necessary to incorporate revisions.

Use of object-oriented technology in the federal sector is now minimal, but the government's Information Resource Management (IRM) executives appear to recognize its benefits and are interested in obtaining them. However, it is not generally clear to the IRM community how to begin use of object-oriented technology or how to integrate systems produced with object-oriented technology with existing systems.

This report has been written for use by the vendor community to provide a better understanding of current and projected object-oriented technology use in the federal sector. The executive overview has been provided to organizations in the federal sector that participated in the survey in order to acquaint them with activities and perceptions of their counterparts in other agencies.

This report contains 46 pages, including 14 exhibits.

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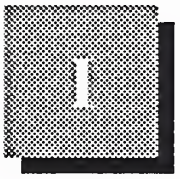


Introduction

This report and the related research were performed as part of INPUT's Federal Market Analysis Program. This program supports management and business planning functions of leading vendors in the information services industry and the information systems function of the federal government by providing detailed analysis related to major information technology issues.

The Federal Market Analysis Program was initiated by INPUT for information industry clients in the federal government market. It is estimated that the contract portion of this market will increase from about $18.6 billion in fiscal year 1993 to about $23.8 billion in fiscal year 1998, exclusive of classified systems and embedded technologies.

Since the program began, INPUT has annually asked interested clients to identify specific business areas, service modes, and issues they consider essential for their federal market planning. Their suggestions were incorporated into this program, and have led to the selection of this report as an appropriate vehicle for providing the information.

INPUT does not detail the full spectrum of information system and services opportunities in each fiscal year because there are more than 35,000 individual procurements annually. Instead, the program examines the driving factors and establishes the basis for forecasting individual service mode growth prospects. The federal market analysis reports provide more fiscal-year detail and trends within each delivery mode and by agency.

The companion Federal Information Technology Procurement Program focuses on only those opportunities of significant new or recompete interest to INPUT's vendor clients. More than 500 of these opportunities are provided in the *Procurement Analysis Report* data base, issued bi-weekly. A newsletter summarizing recent data base modifications and procurement issues is distributed to INPUT's federal vendor clients monthly.

A
Scope

This report examines the use of object-oriented technology in the federal government. The focus of the report is on:

- Present and planned use of the technology
- Perceived benefits of object-oriented technology
- Perceived obstacles to the implementation of object-oriented technology
- Vendor opportunities to support the implementation of object-oriented technology

B
Objectives

This report addresses the following issues:

- Are the concepts of object-oriented technology understood in the federal government technology environment?
- What are the benefits perceived by the federal community in adopting object-oriented technology?
- To what extent is object-oriented technology currently used?
- What benefits have been obtained in object-oriented technology use to date?
- How will the use of object-oriented technology change in the next three years?
- What barriers to further implementation of object-oriented technology exist?
- What are the implications of these barriers to providers of object-oriented technology?
- How can object-oriented technology providers facilitate the implementation of their products and services?
- What is the size of the object-oriented technology market and how will it expand over the next five years?

- What are the characteristics of new vendors and products entering the object-oriented market?

C
Methodology

This report was developed based on survey data collected from selected management from each department and major agency of the federal government. Initial contact was made at the agency IRM executive level. In most instances, subsequent interviews were held with subordinate staff.

Interview discussions were structured, but allowed to range over the object-oriented technology subject matter based on interviewees' knowledge and interest. Data was collected about each respondent's systems development plans and activities. As outlined in Chapter III, Survey Findings, survey participants were asked about their current and future systems development activities and to what degree the use of object-oriented technology would be a factor. Participants were asked if they felt that an object-oriented approach was applicable to their organization's needs and what benefits its use would provide. Relative to their own organizational setting, participants were asked what transition actions would be necessary to make effective use of object-oriented technology. Participants were then asked how they thought the vendor community could best support their efforts in adopting object-oriented methods. Finally, participants were asked to identify other issues or trends they felt would be significant in their use of object-oriented technology. Tabulations of question responses are presented in Chapter III.

In addition to the primary input from department and agency sources, the secondary sources of information were as follows:

- Interviews with vendors of object-oriented technology products
- Interviews with standards organizations
- Nonproprietary insights from custom research and consulting studies
- Ongoing interaction with technical experts and practitioners

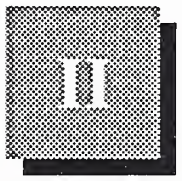
D
Report Organization

Following this Introduction, Chapter II is an Executive Overview that provides an overview of object-oriented technology and today's systems development needs. This chapter summarizes the report's findings and recommendations detailed in other chapters.

The third chapter of the report, Survey Findings, relates the data obtained from interviews with the primary departments and agencies of the federal government. These interviews were conducted to determine the extent to which object-oriented technology has been implemented, and plans for its future use.

Chapter IV, Analysis and Conclusions, presents observations based on the survey findings, draws conclusions relative to the issues and needs of the federal marketplace, and offers recommendations to the vendor community.

The final chapter of the report, Market Forecast, estimates the federal object-oriented technology market size over the next five years and cites the types of products now being introduced.



Executive Overview

This report was developed, and the related research was performed, as part of INPUT's Federal Systems and Services Market Program (FSSMP). This program serves the management of leading vendors in the information services industry and the information system function of the federal government by providing detailed analysis on major information technology issues.

A
Management Perspective

The current state of large-scale systems development is all too familiar. Both large and small organizations find their budgets for system development inadequate to meet the demands they face. The availability and growing use of commercial off-the-shelf software have improved the responsiveness to core business needs but have done little to offset increases in demand.

The use of information engineering disciplines and supporting products has not enabled large organizations to meet the demand for new systems. In fact, expanding the view of systems development needs to an enterprisewide perspective creates a more pessimistic view of the ability of the systems development function to support the growing demands of the organization.

The systems development dilemma continues in spite of the implementation of CASE tools and the distribution of development efforts for local, dedicated platforms.

B
Today's Needs

With the demand for new and re-engineered systems constantly increasing, the visible and latent application backlog is ever-growing. To meet the demand, development methods and tools must achieve a productivity breakthrough.

Open systems and client/server architecture, at a macro level, will reduce the need for systems re-engineering through their scalability, portability and interoperability characteristics. At a micro level, the effect of downsized platforms for development and the availability of supporting individual and group programmer productivity aids is increasing the rate of new systems implementation.

It is convincingly argued, however, that without a different approach to building new systems or re-engineering old ones, we are merely creating tomorrow's legacy systems at a faster rate.

To meet the maintenance burden, systems re-engineering efforts will increasingly attack the costs of supporting legacy systems. Clearly, the opportunity to reduce tomorrow's maintenance burden is at the time the new systems are built or re-engineered.

As even the general public is aware, the economic forces at work in the federal sector have created a fiscal environment in which government downsizing and corresponding cost reductions have curtailed most discretionary spending on new technology initiatives. In particular, the curtailment of DoD spending, the source of new technology assessment and confirmation for many smaller civilian agencies has served to further reduce R&D initiatives.

The emphasis on existing program efficiencies creates increased competitive pressures for further economies. This cost-cutting atmosphere and continual shake-out of government contractors do not foster an environment conducive to investment in new methods requiring significant start-up costs.

One of the problems facing federal agencies is the general lack of experience with object-oriented technologies by officials who are responsible for information system development. More than 86% of the officials interviewed in this study stated they had little or no familiarity with object-oriented technologies. This means agencies may not be prepared in general to manage the technology that could improve their ability to reduce the increase in demand for systems development, and thereby reduce operational costs.

C
Object-Oriented Technology Capabilities

The open systems revolution has driven development and re-engineering efforts to use more economical platforms. The use of client/server architecture integrates open products for presentation and data management. This impetus for new and re-engineered systems to use open architecture has further increased the demand for interoperable components. These trends complement the operational picture of legacy systems in proprietary architecture using a variety of development methods and tools for ongoing maintenance.

Object-oriented technology is being touted as the breakthrough for systems development productivity. By its use, it is anticipated that organizations can make substantial inroads to their application backlogs and can reduce the unit cost of developed systems. A fundamental concept of object-oriented technology is the definition and re-use of objects to specify the data and process needed to support business events. The appeal of the re-use concept is as significant today as it was in the early days of modular programming. Where modular programming sought to structure programmed solutions to increase maintainability, object-oriented technology promises further maintenance reduction by expanding the modules (i.e., objects) to contain process, data and the rules governing their interaction.

Encapsulation of data and process into small modular objects minimizes the impact of unrelated change to other objects. In this way, an object-oriented implementation limits the effect of changes, thereby reducing maintenance cost and time. This characteristic may be an economic motivator to justify what could be substantial investments needed to assimilate object-oriented concepts into systems development practices.

Survey results showed that 77% of agency officials had no operational experience with object-oriented technologies, and 64% were not planning to use object-oriented technologies.

Some confusion exists among agency officials regarding potential benefits and disadvantages of object-oriented technologies. Fifty-five percent believe that the use of object-oriented technologies could reduce development time, and 27% believe that the use of object-oriented technologies could reduce maintenance time and costs. Thirty-two percent believe the use of object-oriented technologies would increase development time and costs.

D

Matching Capabilities to Needs—The Vendor Perspective

In offering any new product or service, the successful vendor must provide the functional capability and meet user needs at a competitive price. However, in introducing products or services using new technology, the vendor must understand the obstacles the customer faces in adopting the technology. Appropriate vendor support is particularly necessary to the customer's success, especially if the technology must be intimately understood by the user to gain its full benefit.

To be successful in such situations, leading vendors must help the customer address the technology transfer needs and provide assistance in removing obstacles the customer faces. The primary obstacles faced by IRM executives are enumerated below. Implicitly, as obstacles to adopting the technology, these factors are also barriers to the acquisition and use of vendors' products and services.

The obstacles faced by federal users in adopting object-oriented technology are summarized in Exhibit II-1.

EXHIBIT II-1

Obstacles to Federal Object-Oriented Technology Adoption

- Education in object-oriented technology concepts and how they would relate to program responsibilities
- Understanding of obtainable benefits relevant to the particular agency or program
- Development of cost/benefit decision-making models
- Technology planning to integrate object-oriented technology with existing development and operational capabilities (methods, tools, and skills)
- Implementation support of new methods and tools
- Concept and skill training at the practitioner level
- Removal of cultural barriers in the customer's organization

E
Related Issues and Trends

Object-oriented technology has been termed the "second industrial revolution" and the solution to the information systems backlog. Object-oriented technology has also been called "the client/server second wave." However, the move to open systems using cooperative, distributed and networked computing architecture may be saturating the user's ability to absorb technology change.

To be a significant factor in contemporary development and re-engineering projects, object-oriented methods and tools must be integratable with current development activities. Ideally, support from vendors should span the technical architectures being used in today's projects, the activities of which range across technical environments and platforms to include mainframe-based, standalone PC-based, and various forms of distributed computing. Further, to be compatible with the open systems direction being taken by most organizations, object-oriented technology solutions must also be open—i.e., scalable, portable, and interoperable.

Recognizing that the introduction of object-oriented technology must address the obstacles cited above, more than ever, the leading vendors must provide appropriate educational and consultative approaches to the prospective object-oriented technology user. Vendors must show how object-oriented technology works in a way the prospective customer can relate to and in a way that can provide the basis of a cost/benefit model for the customer.

Leading vendors must provide not only tool training, but also must address cultural resistance to the new object-oriented technology paradigm. In short, the leading vendors must be able to meet the pervasive needs relating to changes in their customers' application, technical, and organizational environments.

A wide-ranging list of issues and trends related to object-oriented technologies resulted from responses to this survey. Exhibit II-2 shows the issues mentioned. Client/server was the most frequently mentioned related trend, but it was cited in only 23% of the responses. No other issue or trend was mentioned in more than 14% of the responses.

EXHIBIT II-2

Related Issues and Trends

- Client/server implementation
- Open systems evolution
- Standards development/systems development life cycle use
- Too much technology to absorb
- Business knowledge growth
- Management commitment to modernize systems development process
- Computer science curriculum changes/employee technical knowledge
- Improved LAN platform robustness
- Small project opportunities
- Network capacityimprovements

F
Conclusions

Federal agency officials (15 of 22) responsible for application development indicated that their familiarity with the concepts of object-oriented technologies was limited to impressions formed from general information obtained from industry publications, peer conversations, and other incidental sources.

Most officials (17 of 22) reported that their organizations were not using any object-oriented technology. Only half (11) were presently using, planning to use, or evaluating the use of the technology.

The benefits cited by the participants were heavily skewed toward reduced development time/cost (18 of 22), premised on eventual payback of reusable code. As a disadvantage, several participants (7 of 22) noted an initial investment period when development efforts would take longer and cost more than with traditional software development tools.

Education, training, and organizational culture issues led the responses for transition actions required to implement object-oriented technologies.

Requirements for education appeared most often (8 of 22) as requests from vendors. Following this, new methods and tools was the most common response (7 of 22). Many respondents cited that object-oriented capabilities should be added to present tools, as opposed to buying and training on new tool sets. Several respondents felt new tools would be definitely required.

A disadvantage cited in object-oriented technologies was the difficulty of integrating new object-oriented systems with existing legacy systems. This "disadvantage" is related to the trend of integrating new systems with old systems using smaller platforms. The view of most respondents was that the trend to smaller platforms in a highly distributed environment will further complicate, and probably retard, the implementation of object-oriented technology.

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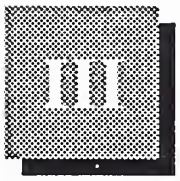


Survey Findings

Primary research surveys were conducted with participants from 22 agencies, including all major departments. This section summarizes survey participants' responses relative to:

- Their familiarity with object-oriented technology
- Their organization's present and planned use of the technology
- The benefits they have experienced and/or anticipate from use of the technology
- Required steps they felt must be taken for them to make a transition to the technology
- What support they desired from vendors
- Other issues and trends they thought were relevant to their implementation of object-oriented technology

A
Familiarity With Object-Oriented Technology Concepts

Results of the following question asked of the respondents, "How familiar are you with the concepts of object-oriented technology?" are shown in Exhibit III-1.

Typically, those responding "not at all familiar" or "only slightly familiar" indicated that their knowledge was limited to general impressions formed from general information obtained from industry publications, peer conversations, and other incidental sources.

Those responding "moderately familiar" had done additional reading, attended seminars, or had some specific educational experience.

Those responding "very familiar" had a more extensive education experience and/or had direct knowledge of object-oriented technology use.

EXHIBIT III-1

Object-Oriented Technology Familiarity

Familiarity with Object-Oriented Technology	Number of Respondents
Not At All Familiar	2
Only Slightly Familiar	13
Moderately Familiar	4
Very Familiar	3

The majority of respondents who indicated some familiarity but no experience with object-oriented technology (17 of 20) had been influenced by promotional aspects appearing in newspapers, journals, and vendor material. These publications characteristically extol the virtue of new things, emphasizing benefits rather than drawbacks. These respondents might be more eager to explore object-oriented technologies further than respondents with no familiarity at all. A more accurate assessment of the overall value and liability of this technology can be expected from actual users of the technology.

B

Present and Planned Usage

The survey asked the respondents, "Are you presently using object-oriented technology? Do you plan to?" Results are shown in Exhibit III-2.

Not surprisingly, most organizations (17 of the 22 participating) were not using any object-oriented technology. However, 11 of those responding were presently using, planning to use, or evaluating the use of the technology.

Several of those who were not planning to use object-oriented technology felt it had no applicability to their program requirements. In these cases, the respondents viewed their program requirements as "basic record-keeping" and did not equate their needs with the use of object-oriented technology.

The agencies that were "presently using" or "planned to use" object-oriented technology had selected a significant "business" function. This function was either a "mission-critical" application or an "agency-wide" application.

EXHIBIT III-2

Present and Planned Object-Oriented Technology Use

Object-Oriented Technology Experience—Present/Planned	Number of Respondents
None / None Planned	11
None / Evaluating	5
None / Planning To	1
Some / No More Planned	2
Some / More Planned	3

C

Perceived Benefits and Disadvantages—Anticipated and Experienced

When asked, "What benefits or disadvantages do you anticipate or have you already experienced in using object-oriented technology?" the respondents replied as shown in Exhibit III-3 (benefits) and Exhibit III-4 (disadvantages). Multiple responses were allowed.

The benefits cited by the participants were heavily skewed toward reduced development time/cost, premised on eventual payback of re-usable code. As a disadvantage, several participants noted an initial investment period during which development efforts would take longer and cost more than with traditional software development tools.

Reasons cited were increased analysis and design time for foundation applications (i.e., attributable to object-oriented technology itself), and overall increases in the development cycle attributable to staff learning curves. The learning curve startup disadvantage was also cited as a significant obstacle to object-oriented technology use.

EXHIBIT III-3

Object-Oriented Technology Benefits

Anticipated and/or Experienced Benefits	Number of Respondents
Reduced Development Time/Cost (future applications)	12
Reduced Maintenance Time/ Cost	6
Improved Development Quality	3
Purchase of Class Libraries	1
Easier to Distribute Applications	1
Promotes Open Environment	1
Produces Scalable Applications	1

Because only three respondents indicated familiarity with object-oriented technologies (Exhibit III-1), most responses shown in Exhibit III-3 were probably directed toward anticipated benefits rather than experienced benefits. The views of these respondents would have been driven by vendor promises or promotional material in the trade press.

The fewer numbers of responses to disadvantages shown in Exhibit III-4 may have resulted from a lack of experience with the technology. Robustness of features, performance problems, difficult implementation, and unproved benefits collectively suggests that actual experience with object-oriented technologies has had serious negative impacts.

EXHIBIT III-4

Object-Oriented Technology Disadvantages

Anticipated or Experienced Disadvantages	Number of Respondents
Learning Curve Will Cause Increased Development Time/Cost (initial applications)	7
Immature Environment/Lack of Robust Features	2
Performance Problems on Large Systems	2
Difficult to Implement with Existing Systems	2
Unproved Benefits	1

D
Required Transitional Actions

Responses to "What transitional actions will be required for your organization to make effective use of object-oriented technology?" are shown in Exhibit III-5 (multiple responses were allowed).

EXHIBIT III-5

Required Transition Actions

Required Transition Actions	Number of Respondents
Staff Education/Culture Change	9
Better Use of Systems Development Life Cycle/More Structured Engineering Approach/ Expanded Use of CASE Tools	7
Staff Training	6
Need To Demonstrate Benefits/Use of Prototype Projects	5
Use of Open Systems-Client/Server Architecture	4
Increased Business Knowledge	3
Expanded Data Administration Role and DBMS Implementation	3
Support in Existing Operating System and Data Base Management System Software	2
Implementation of Repository	1
Improved CASE Tool Integration	1

The responses shown in Exhibit III-5 correlate with those to the question, "What obstacles are there to the adoption of object-oriented technology in your organization?"

Training was cited separately from education. Training was associated more with the use of new techniques, methods and tools. Education was cited in the context of understanding the benefits of object-oriented technology and was stated as a need in the context of a "cultural factor" for the technical staff to overcome. Several respondents felt so strongly about this barrier they believed that the transition would be made only with the influx of new staff with contemporary computer science educational backgrounds.

Actions appearing in the top half of the table in Exhibit III-5 deal with use of object-oriented technologies. The role of staff is emphasized in the responses to this question. Actions appearing in the bottom of the table deal with technology infrastructure. Though these actions are important to some, the focus on requirements to make the transition to object-oriented technologies is clearly people-oriented.

E
Vendor Support Needs

The responses to the question, "What support do you want from the vendor community to implement object-oriented technology?" are shown in Exhibit III-6 (multiple responses were allowed).

EXHIBIT III-6

Vendor Support Needs

Support Needs from Vendors	Number of Respondents
Education	8
New Methods and Tools	7
Staffing Support	7
Training	6
Demonstrations/Cost-Benefit Models	6
Adaptation of Existing CASE Tools	5
Consulting Services	3
Application Management	3
Joint Prototyping	3
Participation in Standards Development	2
Class Libraries/Off-the-Shelf Applications	2
Documentation Support	1
Improved Product Maintenance	1

Predictably, new methods and tools were mentioned frequently in the responses. Many respondents believed object-oriented capabilities should be added to present tools instead of organizations acquiring and training on new tool sets. Several respondents felt new tools would be definitely required.

Again, education and training were mentioned frequently (8 and 6, respectively), and education was differentiated from training. Training was associated with new methods and tools. Education, on the other hand, was cited in the context of rationale and justification for the use of object-oriented technology.

Many respondents (6) replied that vendors must provide the rationale that supports object-oriented technology implementation in the form of decision-making models.

Consulting services (3) was an infrequent response. These services were viewed in the light of integration. When pressed about why such services would not be significant to user success, several respondents said that they thought integrators would add little value. This view may simply indicate that object-oriented technology projects are presently thought of in narrower terms than large-scale development projects.

There were two different perspectives on vendor support. Several participating organizations typically contract for all aspects of development projects using vendor support to provide staffing and to determine what methods and tools are used. In such a context, the contractor would make the decisions to use object-oriented technology. For these organizations, application management was one inclusive need. From this perspective the application management response should be considered a response to all of the vendor capabilities.

Most of the organizations, however, responded to the vendor support question from the perspective of multiple vendor capabilities. Judging from this response, most organizations view vendor technical services or staffing support as distinct from other vendor capabilities.

F

Related Issues and Trends

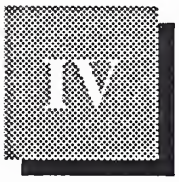
Respondents were asked, "What related issues and trends will affect the implementation of object-oriented technology?" Responses are shown in Exhibit III-7 (multiple responses were allowed).

EXHIBIT III-7

Related Issues and Trends

Issue or Trend	Number of Respondents
Client/Server Implementation	5
Open Systems Evolution	3
Standards Development/Systems Development Life Cycle Use	2
Too Much Technology to Absorb	2
Business Knowledge Growth	2
Management Commitment to Modernize the Systems Development Process	2
Computer Science Curriculum Changes/ New Employee Technical Knowledge	2
Improved LAN Platform Robustness	2
Small Project Opportunities	1
Network Capacity Improvements	1

Although "Client/Server Implementation" was the most frequently mentioned related issue, it represents only a small ratio (5 of 22) of responding agencies. The wide range of responses shown in Exhibit III-7 with only a few mentions each suggests few if any common issues that apply to object-oriented technology implementation. A lack of experience could explain this shallow spread of related issues. Government officials don't appear to have a clear view of the potential impacts of object-oriented technologies in their agencies.



Analysis and Conclusions

The findings of this survey indicate that the move to implement object-oriented technology has begun but will progress at a slow and uneven pace in the federal sector. Although the experience and immediate plans of federal IRM executives are limited, their conceptual knowledge about object-oriented technology is not. The survey respondents have varied direct experience and technical knowledge. In general, they have a common interest in obtaining systems development economies through the use of object-oriented technology.

A
General Observations

Only a few of the executives surveyed had direct experience in the implementation of object-oriented technology. About half of those interviewed were beginning to use or were evaluating the use of object-oriented technology.

The benefits in systems development productivity through reusability of program code was the primary benefit anticipated by the respondents. The executives who had direct experience were enthusiastic in their views about the benefits they hoped to obtain. From his experience to date, one such executive cited productivity gains at "an order of magnitude." Maintenance efficiency as a benefit was also a leading response. Several respondents cited improved quality (expressed as reliability) as an anticipated benefit.

Among the disadvantages cited, significant increases in development time for initial systems projects are anticipated. This disadvantage is attributed to the learning curve. This view underscores the more general perception of an object-oriented approach being a fundamental change to the development process. The perception of increased difficulty and time associated with adoption of object-oriented technology was almost universally shared.

For many respondents, the adoption of object-oriented technology was coupled with open systems and a move from what was called "the mainframe mentality" of the federal sector. Therefore, some respondents related concern about their ability to support mission-critical systems on platforms with less than the "industrial-strength" level of support provided by their mainframe environments. This view was expressed by concerns about the lack of features on small platforms and about performance and capacity issues.

Another disadvantage cited was the difficulty of integrating new object-oriented-based systems with existing legacy systems. This "disadvantage" is related to the trend of integrating new systems with old systems using smaller platforms. The view of most respondents was that the trend to smaller platforms in a highly distributed environment will further complicate, and probably retard, the implementation of object-oriented technology.

B

Impact on Systems Development

The collection of views and information obtained from the discussions with IRM executives reveals a clear understanding at the management level of the benefits and obstacles in using object-oriented technology. There is near-unanimous recognition that an object-oriented approach significantly impacts existing systems development activities. In particular, an object-oriented approach requires a different analytical perspective focusing on business events, rules and associated data. The respondents' knowledge of the technical specifics is understandably vague, but there is general awareness of the impact on tools and related staff skills. More technical issues, such as object libraries and encapsulation of legacy system components, are not as well understood.

Associated with the recognition that front-end analysis life cycle phases will be affected, many respondents felt that the orientation of their current data administration function toward physical data base management would have to change significantly and embrace a more logical understanding of business requirements and data needs.

C

Education and Training Needs

Education on object-oriented technology concepts was the leading and most consistently voiced concern among the respondents in this study. Some respondents viewed the education need as focused on analysts and designers; some viewed the need as more focused on programming languages and tools; others viewed the need as educating top management about the benefits of an object-oriented approach to systems development.

Of those who cited top management education as a priority, most thought of it as an organizational prerequisite for the introduction of object-oriented technology. Closely coupled with management education was the need to prove the benefits of the approach. In general, the respondents felt that their understanding of object-oriented technology was just conceptual and that real strides in its implementation would be predicated on a clear understanding of tangible, attainable benefits. In this regard, several respondents felt that joint prototypes should be conducted as demonstration projects to show attainable benefits and to provide relative education.

Training followed education as a consistent response. In general, the severity of the technical impact on today's development staff and their ability to rapidly assimilate new approaches and technical skills was pessimistically viewed as a major obstacle. Some respondents stated that staff capabilities would change only as the staff changed, and that object-oriented technology would be successfully used only by new employees who had learned object-oriented concepts in an academic computer science environment. Nonetheless, all respondents felt that training for methods and tools would be a vendor responsibility.

D
Transition Needs

Beyond initial education and ongoing training, findings concerning additional transition needs centered on infrastructure and project support. Infrastructure changes related to an expanded role for data management, to greater use of system engineering-oriented system development life cycle methodologies, to increased use of CASE tools, and to conversion to relational data base management systems.

The expanded role for the data administration function includes a wider scope of business requirements and logical views of the organization and its overall systems needs. Transition to an agencywide purview will be significant for most respondents because most of the organizations surveyed now limit their data management function to design and physical control of data bases. This narrower view of data administration reflects the generally prevalent mainframe orientation.

Many of the organizations surveyed were not following a system engineering approach for their development process and therefore make limited use of CASE tools. The transition to a more formal systems development methodology, emphasizing full life cycle CASE, was cited as a transitional action necessary before implementing object-oriented technology.

Most organizations also viewed the evolution to relational data base management systems as a part of open systems and the use of client/server architecture. Because most respondents viewed the evolution to open

systems as a step related to the move to object-oriented technology, implementation of relational data base systems was viewed as a prerequisite.

E
Agency Attitudes and Directions

Although the benefits of object-oriented technology are clearly understood, there is substantial confusion about how the approach "fits in" to open systems and client/server trends. It is also clear that there are significant steps most agencies must take in creating the systems development infrastructure to support a migration to object-oriented systems. However, based on the needs of the IRM community and its perceptions and plans relating to the implementation of object-oriented technology, a number of recommendations can be made relative to meeting the support needs of the federal customer.

In considering the needs of the IRM organization, of particular note are the expected obstacles to be overcome for the successful use of object-oriented technology. These obstacles provide criteria for assessing the value of potential products and services when viewed as critical success factors.

As stated by the IRM executives, these obstacles include the following:

- Understanding of object-oriented concepts and knowledge of its current implementation
- Understanding of how obtainable benefits would be relevant and would benefit a specific IRM program
- Availability and acceptance of cost/benefit decision-making models
- Availability and support for new methods and tools
- Conceptual understanding and skill availability at the practitioner level
- Integration of object-oriented systems with existing operational systems
- Cultural barriers to the use of object-oriented technology in the customer's organization

Recognizing these needs and critical success factors, the following recommendations should be considered in providing acceptable products and services to the federal marketplace:

- Provide education on concepts and benefits for all levels of the organization.
- Develop prototype projects as a demonstration concept and benefits; where possible, conduct joint prototyping activities with the federal sector.
- Develop and distribute decision-making models that evaluate the potential use, cost and benefits of an object-oriented approach.
- Use a clear systems development methodology; cite recommended transition from current methodologies to object-oriented methodologies.
- Develop and articulate a CASE tool strategy citing present tool adaptation and new tool purpose.
- Develop planning guidance to address the integration of object-oriented systems with legacy systems across different technology platforms.
- Develop organization development strategies and conduct joint planning with customer organizations to address cultural issues and constraints.

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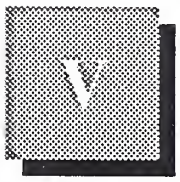


Market Forecast

It can be expected that the use of object-oriented technology by the federal government will lag behind its use in the commercial sector. However, as the results of this survey show, the typical federal IRM manager is cognizant of the benefits of object-oriented technology and, in many instances, actively evaluating its use. The forecasts presented in Exhibit V-1 provide an overview of the federal software market's potential for the use of object-oriented technology and its projected growth over the next five years.

A
Market Projections

The future market size of the object-oriented technology is staggering. Estimates for worldwide revenues range to $4 billion by 1997, by which time object-oriented technology will be integrated into full CASE support. Though the adoption of object-oriented technology in the federal sector will be slower, it can be assumed that it will gain an increasing share of federal software expenditures. While at no more than a few percent today, it is conservatively estimated that the use of object-oriented technology will exceed 25% of software development revenue by 1998. Based on the projections of total federal software expenditures provided in Exhibits V-1 and V-2 below, by 1998 market share of object-oriented technology-based products for civilian agencies will exceed $117 million and for defense agencies will exceed $83 million. This $200 million total does not include expenditures for professional services, which for many program initiatives will utilize object-oriented technology as a core requirement.

EXHIBIT V-1

Projected Expenditures for Software and Professional Services by Civilian Agencies (x $000)

	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	CAGR (Percent)
Software	385	385	414	437	455	469	4.05%
Professional Services	1,097	1,147	1,269	1,369	1,485	1,604	7.88%

EXHIBIT V-2

Projected Expenditures for Software and Professional Services by the Defense Department (x $000)

	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	CAGR (Percent)
Software	343	273	293	310	323	333	-0.64%
Professional Services	354	294	323	347	374	402	2.58%

Exhibit V-3 depicts projected expenditures for direct software acquisitions. Using the conservative 25% estimate, acquisitions that will be affected, if not dictated, by the support of object-oriented technology will exceed $206 million. No estimate has been made for that portion of professional services relating specifically to object-oriented technology. But undoubtedly, a significant share of the $200 million combined civilian and defense total will draw on new products and services that will use object-oriented technology. Further, perspective on object-oriented technology impact should include the complete range of professional

EXHIBIT V-3

Projected Expenditures for Software, Including Acquisitions and Licenses (x $000)

FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	CAGR (Percent)
728	678	729	769	802	827	2.56%

EXHIBIT V-4

Projected Expenditures for All Professional Services, IncludingTraining and Related Systems Engineering Support (x $000)

FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	CAGR (Percent)
1,432	1,419	1,569	1,691	1,834	1,980	6.69%

B

Object-Oriented Products

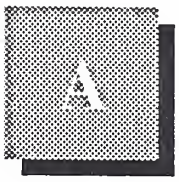
Established vendors to current development needs are developing new products or adapting existing ones to include object-oriented approaches and capabilities. Additionally, new products developed to produce object-oriented development have entered the marketplace. Primarily, these products address the tool needs for specific life-cycle phases and do not provide fully integrated CASE solution. In general, products currently in use can be categorized as languages and programming tools, developer's tool kits, object-oriented databases, and object-oriented CASE tools. To date, few products have been introduced which both support object-oriented methods and which were developed using object-oriented technology.

Exhibit V-5 cites representative products from established and new vendors which address full and specific life-cycle phases.

EXHIBIT V-5

Representative Object-Oriented Products

Vendors/ Product Type	Integrated CASE	Life-Cycle Phase Specific
Established Vendors	Teamwork (Cadre ObjectView (KnowledgeWare)	C++ ObjectVision (Borland) Visual C++ (Microsoft) ObjectCenter (Centerline)
New Vendors	Objectory (Objective Systems) Rose (Relational Systems)	ProKappa (Intellicorp) Smalltalk V(Digitalk) Gemstone (Servio) VisualWorks (ParcPlace)



List of Agencies and Survey Respondents

DOA/Animal Plant Health Inspection Service: Leslie Nanney, Agency Systems

DOC/Census: Mo Levin, Systems Support

DOC/National Oceanic & Atmospheric Agency: Robert Swisher, Systems Development

DOC/PTO: Rob Porter, Systems Architect

DoD/DISA: Colonel Dirnberger, Information Systems

DoD/Navy: Capt. Richard Bostian, SPAWAR

Education: Linda Tague, Technology Resources

Energy: Ron Shore, IRM Policy, Plans & Oversight

Environmental Protection Agency: Paul Wohlleben, Information Resources Management

General Services Administration/IRMS: Otto Doll, Information Management

Housing and Urban Development: George Suggs, Systems Engineering Group

Interior/U.S. Geological Survey: Eric Summers

Justice/Drug Enforcement Agency: Phil Camero, Information Systems

Just/Immigration & Naturalization Service: Dan May, Quality Assurance

Justice/HQ: Betty Brown, Systems Development Services

Justice/U.S. Marshalls Service: Rod Poalini, Information Technology

Labor/IRM: Kenneth Mills, Information Resources Management

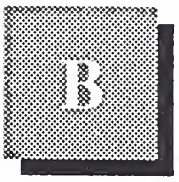
Labor/Systems: Dave Miller, Systems Analysis

NASA/HQ: Russell Rice, Automated Information Management

Transportation/FAA: Timothy Carrico, Special Projects

Treasury/ATF: John Purcell, Applications Software

Treasury/Bureau of Engraving & Printing: Tom Rinehart, Information Systems



Definitions

Terms used in this report which may require definition are cited below.

Class—a template for defining the methods and variables for a particular type of object.

Encapsulation—a technique in which data is packaged together with its corresponding procedures.

Enterprise Modeling—the process of building and using a working model of an organization to understand the process of that organization and to implement some of its functions in software.

Message—a signal from one object to another that requests the object to carry out one of its methods.

Method—a procedure contained within an object that is made available to other objects for the purpose of requesting services of that object .

Modular Programming—a general approach to programming in which programs are broken down into components called modules, each of which contains its own procedures and data such that each module is independent from others.

Object—a software packet containing a collection of related data and procedures (methods) for operation on the data.

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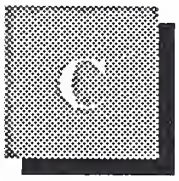

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1. David A. Taylor, *Object-Oriented Technology: A Manager's Guide*, Addison-Wesley Publishing Company, Inc., Reading, MA, 2nd Printing, 1993.

2. James Martin, *Principles of Object-Oriented Analysis and Design*, PTR Prentice-Hall, Inc., Englewood Cliffs, NJ, 1993.

3. *"Object Management Group White Paper,"* Object Management Group, undated.

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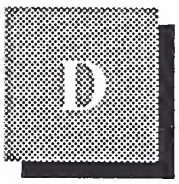

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Federal Information Technology Procurement Program, Procurement Analysis Reports

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- *Uncompensated Overtime*
- *Federal 8(a) Programs*
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Federal Systems Integration Market, 1992-1997

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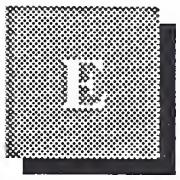

Survey Letter and Questionnaire

Dear Agency Official:

Recently, INPUT distributed to federal agency Information Resource Management officials a summary of its findings from research conducted into systems integration requirements of federal agencies. If your office has not received a copy of this summary, and you would like to have one to distribute to your staff, please contact me directly.

As part of its continuing program to educate vendors regarding federal agency information technology requirements and concerns for protecting existing operational systems within federal agencies, INPUT is now examining the object-oriented technology market. Object-oriented technologies promise many benefits to application development programs. The potential for low maintenance costs, a high degree of software re-use, and more reliable modular program segments head up a list of benefits that vendors are marketing with their object-oriented technology packages. Users of this technology may have their own perceptions of the potential value of object products within their organizations. Vendor awareness of these perceptions, and other specific issues within federal agency programs, is important if agencies want to take best advantage of available capabilities in the marketplace.

We would like to include your organization's application development requirements in this study and, in turn, to inform you of the interests and concerns of application development issues in other federal agencies. Sharing of experiences and solutions between users and suppliers offers a means to leverage application development costs in today's restricted budgetary environment. Your organization's participation would be important to developing the best overall descriptive information of the federal application development environment. A senior research analyst will be calling your office in the next few days to get the name of the most appropriate official on your staff to assist in collecting the necessary information. I anticipate that no more than fifteen minutes would be required to complete the telephone interview. As always, interviews are treated as confidential. Only summary information is released to the public; agencies and officials will not be identified.

Thank you in advance for your cooperation.

Best regards,

Robert Deller, Ph.D.
Federal Program Manager

Object-Oriented Technology Questionnaire

1. How familiar are you with object-oriented systems development?

   If not at all, who in your organization would be?

   Name: _____ Telephone: _____

2. What is the level of involvement that your organization has had with object-oriented software?

   a. Not interested (go to question 4)
   b. Just getting started
   c. Have some development experience
   d. Implemented at least one application
   e. Have re-used an application (or a portion of one)
   f. Have re-used an application on the enterprise level

3. What experience has your organization had with object-oriented software? i.e., doing what, with what benefits, with what obstacles, etc.?

   Doing what?
   a. Requirements analysis
   b. Data design
   c. Process design
   d. Programming
   e. Application interoperability

   What benefits?
   a.
   b.
   c.
   d.

   What obstacles?
   a.
   b.
   c.
   d.

4. What is the present profile of the applications development effort in your organization?

   a. All applications development—i.e., using all methods and technology?

      1. Number of applications _____

      2. Development staff

	Number	Cost
Analysts	_____	_____
Programmers	_____	_____
Other _____	_____	_____

      3. Overall software development cost _____

   b. For applications development using object-oriented technology?

      1. Number of applications _____

      2. Development staff

	Number	Cost
Analysts	_____	_____
Programmers	_____	_____
Other _____	_____	_____

      3. Software development cost _____

5. What will be the profile of the applications development effort in your organization?

a. All applications development—i.e., using all methods and technology?

	Number/Percent Change 2 Yrs. Out (FY 1995)	5 Yrs. Out (FY 1998)
1. Number of applications	_____/_____%	_____/_____%
2. Development staff		
Analysts	_____/_____%	_____/_____%
Programmers	_____/_____%	_____/_____%
Other _____	_____/_____%	_____/_____%

3. Software development cost
Amount _____ Percent change_____%

b. For applications development using object-oriented technology?

	Number/Percent Change 2 Yrs. Out (FY 1995)	5 Yrs. Out (FY 1998)
1. Number of applications	_____/_____%	_____/_____%
2. Development staff		
Analysts	_____/_____%	_____/_____%
Programmers	_____/_____%	_____/_____%
Other _____	_____/_____%	_____/_____%

3. Software development cost
Amount _____ Percent change_____%

6. STAFFING SOURCES

a. What is/will be the profile of development staffing resources for your non-object-oriented-based applications development? (indicate cost/percent for each)

	Now	2 Yrs. Out (FY 1995)	5 Yrs. Out (FY 1998)
1. In-house development	_____/_____%	_____/_____%	_____/_____%
2. Contractor development	_____/_____%	_____/_____%	_____/_____%
3. Off-the-shelf applications	_____/_____%	_____/_____%	_____/_____%

b. What is/will be the profile of development staffing resources for your object-oriented-based applications development? (indicate cost/percent for each)

	Now	2 Yrs. Out (FY 1995)	5 Yrs. Out (FY 1998)
1. In-house development	_____/_____%	_____/_____%	_____/_____%
2. Contractor development	_____/_____%	_____/_____%	_____/_____%
3. Off-the-shelf applications	_____/_____%	_____/_____%	_____/_____%

7. TOOLS SOURCES

a. What is/will be the source of tool support for your non-object-oriented-based applications development? (indicate cost/percent for each)

	Now	2 Yrs. Out (FY 1995)	5 Yrs. Out (FY 1998)
1. Use of in-house-developed tools	_____/_____%	_____/_____%	_____/_____%
2. Use of vendor-supplied tools from platform vendors from development support vendors	_____/_____%	_____/_____%	_____/_____%
3. Other _____	_____/_____%	_____/_____%	_____/_____%

b. What is/will be the source of tool support for your object-oriented-based applications development? (indicate cost/percent for each)

	Now	2 Yrs. Out (FY 1995)	5 Yrs. Out (FY 1998)
1. Use of in-house-developed tools	_____/_____%	_____/_____%	_____/_____%
2. Use of vendor-supplied tools from platform vendors from development support vendors	_____/_____%	_____/_____%	_____/_____%
3. Other _____	_____/_____%	_____/_____%	_____/_____%

8. What platforms are/will be used in your non-object-oriented/object-oriented development efforts? (indicate Y or N)

	Now	2 Yrs. Out (FY 1995)	5 Yrs. Out (FY 1998)
a. Mainframe	_____/_____	_____/_____	_____/_____
b. Midrange	_____/_____	_____/_____	_____/_____
c. LAN	_____/_____	_____/_____	_____/_____
d. Desktop	_____/_____	_____/_____	_____/_____

9 What other needs must be addressed to be successful in the use of object-oriented technology?

_____

_____

10. What obstacles do you perceive regarding the use of object-oriented technologies? (Rank each of the following on a 5 (most serious) to 1 (least serious) scale.

	Rank
a. Technology maturity—i.e., does object-oriented technology "fit" within other existing or planned development/operational technologies	_____
b. Availability of technology	_____
c. Standards for the technology	_____
d. Ease of use	_____
e. Cost of the technology	_____
f. Assimilation issues	
1. Learning curve for development staff	_____
2. Adaptability to existing environment and systems	_____
g. Risk to legacy systems—ongoing maintainability	_____
h. Other _____	_____

11. What other information do you feel is relevant to the forecast of object-oriented technology in the federal government in the next five years?

a. Problems

b. Opportunities

c. Trends

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