A Framework for Object-Oriented Performance Analysis

Automated Object-Oriented Performance Analysis Project
Learning Systems Institute, Florida State University

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Project Team

Dr. Ian Douglas, Project Director
Dr. Scott Schaffer, Project Co-Director
Rachel Lewis, Coordinator

Judd Butler
Michelle Lalikos
Raymond Lillibridge

Student Research Assistants

Andrea Gallagher
Yoonhwa Lee
Valentina Malaxa
Robert Norton

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Background

The Project

This report is the first of several deliverables in a two-year project between the Learning Systems Institute of Florida State University and the Information Systems Directorate of the United States Army Training and Support Command. The project began in September 2001 and was based on an initial concept paper (Douglas and Schaffer, 2001). The project goal is two-fold: to describe analysis processes that are required to support design, development, and evaluation of performance improvement solutions and to develop a prototype tool to support collaborative analysis and specification of reusable performance improvement materials. This goal supports and encourages the development of a human performance support orientation and capacity within the current Army environment.

The Problem

In recent years, the academic and workforce development communities in the United States have become increasingly concerned with the cost effectiveness of student and employee development processes. Efforts to improve the return-on-investment (ROI) of such development have been hindered by a craft orientation to the design and construction of learning and performance support systems. Such an orientation is expensive since it relies on the knowledge and experience of a few expert performers rather than using a standardized approach that is accessible to all performers. One solution to this problem has been to enhance the reuse of learning and performance support materials that had been developed earlier for purposes similar to the ones in this project. The idea behind reuse is that new systems will largely be constructed of standardized, reusable objects derived from object repositories on the Web rather than built from scratch in a craft-oriented manner.

Efficient identification and construction of useful objects requires, at minimum, knowledge of learning and performance design strategies and principles. Currently much energy is being expended to create the technological framework necessary for an object-based approach to learning system development. However, there appears to be little consideration given to the changes in analysis and design thinking required for the move towards object-based systems. Such systems require analysis of human performance problems and identification of related performance support tools that will address those problems across organization and individual system levels. Lessons from software development have shown that it is not enough to have object-oriented construction technologies and standards; reuse and object thinking must also permeate analysis and design thinking. This approach requires the development of tools based around modeling notations for analysis and design of object-based systems.

The History

Following World War II, the United States military began to focus on the development of a training system that would allow it to use systematic processes to maintain its force capacity. The training system that emerged in the early 1970s was based on the principles of a new field of study – instructional systems design (ISD). The techniques and methods of ISD were essentially based on the application of principles of learning psychology to education and training settings. While the systematic ISD approach has been generally lauded as a success, some evidence suggests that traditional approaches to training systems development may not adequately take into account new developments in technology. Instructional systems design has also been criticized for being too linear, inflexible, and centered on only one solution to enhancing human performance, i.e., training (Gordon & Zemke, 2000).

The professional field of instructional design has also been greatly impacted by the increase in "on-demand" information required to support the performance of a worker or team. The ever-increasing appetite for just-in-time web-based training and performance support products requires a shift of thinking from purely instructional design to performance, learning, and information system design (Gery, 1991). More recently, a performance-centered approach to the design of electronic performance support systems (EPSSs) has emerged (Raybould, 2000; Dickelman, 2000; Gery, 1991). This approach relies quite heavily on the analysis of the performer and the total performance environment in an attempt to design solutions intimately tied to the work context. As part of this design approach, potential barriers to performance are removed, and learning is considered a consequence as well as a precursor to performance. Thus, performance support design is somewhat a blend of instructional systems design, performance engineering, and software design. This project seeks to integrate these disciplines to provide a framework and systematic process for designing learning environments. The intention to include a performance support orientation is guided by two recently emerging trends.

The Opportunity

The first trend is the movement away from a training orientation towards a human performance orientation to solve problems. Pioneers in the field of performance technology such as Thomas Gilbert, Robert Mager, and Joe Harless have long advocated the view that organizational system elements such as expectations and feedback, tools and equipment, rewards and incentives, and motivation must be analyzed to identify barriers to performance. The essence of this approach is to identify valuable behaviors that produce measureable results and to remove both individual and work environment barriers to performance (Gilbert, 1998). A study conducted with over 1000 organizations by Huselid (1995) found that human resources practices such as employee selection and recruitment, performance management, incentive systems, employee involvement, and training combined to significantly impact turnover, productivity, and short and long term financial success. This study is significant in that training was but one of many strategies impacting organizational results. By extension, efforts to develop technologies to create and use reusable objects to develop the performance of military personnel should look beyond the limited paradigms of traditional training and personnel development.

The second trend is the move to increase the cost-effectiveness of learning and performance support systems through sharing and reuse of previously developed materials and resources. Traditional methodologies tend to be oriented towards developing integrated, stand-alone systems rather than systems constructed from pre-existing, reusable components. Evidence is inconclusive, however, in determining if the movement to incorporate distributed education and training activities increases learning and performance (Keegan, 1996). By extension, it may also be assumed that the ROI in traditional training and education is relatively low. It is difficult, if not impossible, to determine cost-benefit of potential solutions and ROI of delivered solutions without using a system-oriented approach.

In summary, we want to capitalize on both of these trends by learning more about the efficiency and quality of products created from reusable objects, using actual organizational and individual performance indicators. Our research will be applied in the authentic work setting, focusing on the effectiveness of the Object-Oriented Performance Analysis (OOPA) Framework in the U.S. Army environment.

The Framework

A number of emerging technological standards enable a reusable object approach for the construction of learning and performance support systems. What is needed, however, is a comprehensive approach to methodology which complements the new technologies and standards of object orientation. We envision creating a new methodology similar to the idea of configurable processes developed at IBM (Cameron, 2002), that is, a configurable system-orientated methodology based on a framework of agreed upon and sharable work products that share not only a standard format, but also flexibility in the methods and the construction of those products.

Regarding the history of industrial manufacturing, and software manufacturing specifically, Cox (1990) makes the following point: “Whereas mature engineering domains define standard products and allow diverse processes to be used in making them, in software we do the reverse, defining standard languages and methodologies from which standard components are to magically ensue.” A similar point could be made in regard to the development of instruction and performance support.

A framework is meant to provide a structure for a variety of approaches that can be tailored to specific groups or situations rather than to provide a set of rules for a single correct way of developing systems. The key characteristics of the proposed framework are:

- A human performance-orientation to problem solving
- Object-orientation to match analysis thinking with emerging knowledge/learning object construction technologies

In addition, we recommend the following features for which some form of automated support should be provided:

- Collaborative analysis
- Visual modeling
- Rationale management

Figure 1 illustrates the Object-Oriented Performance Analysis (OOPA) Framework is the basis of this report.

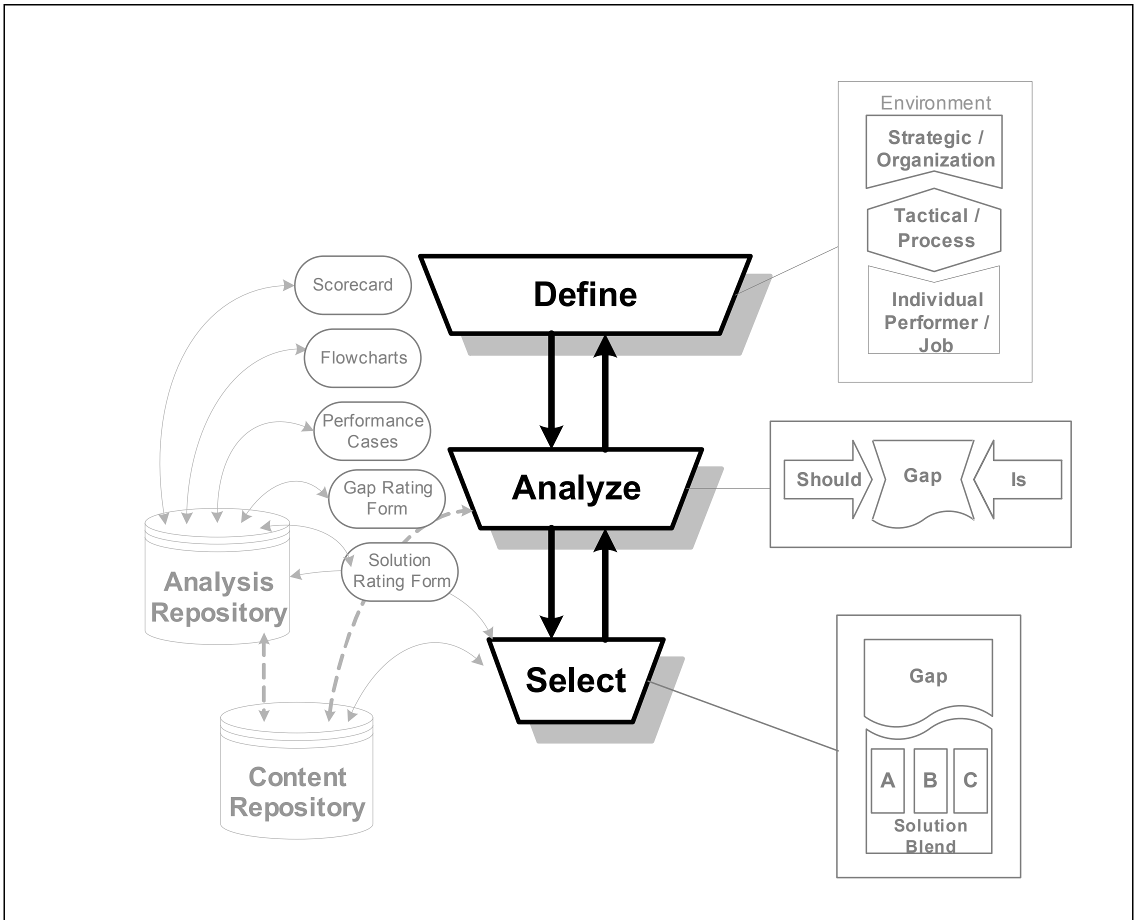

FIGURE 1: OBJECT-ORIENTED PERFORMANCE ANALYSIS FRAMEWORK

Introduction

The following section focuses on the two primary elements of the Object-Oriented Performance Analysis (OOPA) Framework:

- A human performance orientation
- An object-oriented approach to performance support

Human Performance Orientation

The OOPA framework is founded on a basic problem-solving approach common to many disciplines (see Figure 2). Examination of human performance technology (HPT) models reveals that they are all adaptations of that problem-solving approach. Regardless of specific methodologies analysis teams might employ, the most basic elements of *define*, *analyze*, and *select* are present. Based on firm empirical evidence, this framework suggests that organizations should not short circuit the problem-solving process by neglecting the definition and analysis of a problem/opportunity or skipping directly to the selection of a single solution.

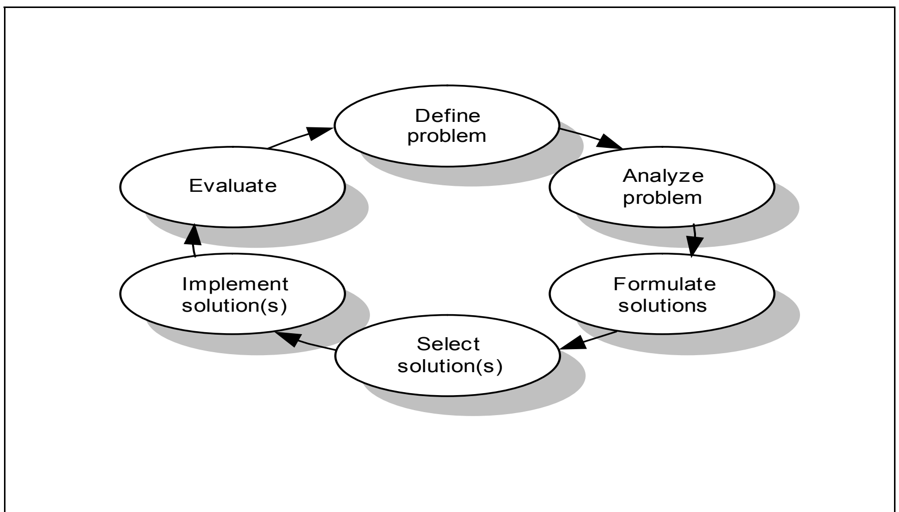

FIGURE 2: GENERIC PROBLEM-SOLVING MODEL

Object-Oriented Approach

The OOPA framework also incorporates an object orientation that matches analysis thinking with object technology. A great deal of work is underway to define conceptually and technically what learning objects are and how they work. This object approach to computer-based instruction follows in the path of object-oriented software development. The software industry has found that object thinking begins not when constructing objects, but much earlier in the process – with analysis (Due, 2002). If objects are to be useful and reusable in a variety of performance solutions (both training and non-training), their characteristics must be considered at each step in the problem-solving process. This framework therefore suggests that organizations committed to reusable objects not rush to the construction of objects at the expense of object thinking in the analysis phase of problem solving.

Integrating Human Performance Technology and Object Orientation

Many organizations have learned that merely providing more information or more training to improve performance is usually insufficient. When training is an inappropriate solution, the use of learning objects simply means doing the wrong thing more efficiently. Human performance technology (HPT) and object orientation (OO) can affect each other in a recursive process: meaningful performance system analysis impacts how one creates and uses objects, and object orientation can facilitate performance analysis. Individually, each of these elements can provide benefits to an organization, but taken together they create a synergy, equipping the organization to respond more creatively, effectively, and efficiently to performance problems and opportunities.

Planning, Problem-Solving, and Analysis

The performance analysis process is a planning process that precedes other solution-specific problem solving or design processes. It would be expected that similar patterns of problem-solving would be found in studying designers in various settings. General problem-solving or planning processes used by expert designers to design products for use in engineering, architecture, accounting, investing, and many other areas are quite similar to the performance analysis process described in this framework. The problem-solving process nearly always involves a definition or redefinition of the problem, some form of analysis of the problem to determine causes, and finally, a solution-selection process.

The planning processes used by performance analysts are similar in many ways, for example, to the diagnostic processes used in clinical decision making by physicians, nurses, and midwives. For example, Cioffi and Markham (1997) investigated how nurse midwives made clinical decisions when presented with a case study. Kuipers et at (1984) studied causal reasoning in medical practice to determine the nature of cause and effect assumptions made by practitioners. In a similar study within the realm of management, Sarasvathy, Simon, and Lave (1998) compared the performance of expert bankers with that of entrepreneurs as both groups grappled with problems related to management of perceived business risk.

Problem-solving methods have also been studied by Perez and Emery (1995), who identified differences in the ways expert and novice instructional designers in the U.S. Army completed a design task. Both groups of designers were tasked to develop instruction for a computer simulation, a task that allowed researchers to study how the design problem was represented and what procedures were used by experts and novices. They found that experts tended to develop the program solution breadth first, while novices developed the solution depth first. Experts interpreted the problem, while novices identified the problem. Experts also represented problems in a more diverse manner, simultaneously exploring combinations of factors, while novices explored fewer combinations and focused on one factor at a time. Finally, and of particular interest to this framework, experts and novices differed on use of procedural, declarative, and strategic knowledge to solve the problem. Procedural knowledge refers to the steps in solving the problem; declarative knowledge refers to the facts, concepts, rules, and principles in the analysis and design process. These types of knowledge are considered to be essential to problem solving (Shadbolt & Wielinga, 1990). Strategic knowledge is the use of action plans to achieve specific goals, requires knowledge of the context in which procedures will be implemented, actions to be taken if a technique fails, and how to respond if necessary analysis information is missing. Both groups used procedural and declarative knowledge to about the same degree, but experts also used strategic knowledge. This important type of knowledge is not reflected in current cognitive theory since it is considered to be acquired through experience.

Studies of this kind help to identify the systems features required to support expert and novice designers respectively. It is our belief that future analyzers and designers will benefit from more focus on the problem finding/problem solving approaches to definition, bounding, and mapping of cognitive as well as behavioral space. We also believe that support of the use of strategic knowledge will allow novice analysts to begin to think more like experts. Finally, it is also important to learn how such approaches are related to successful performance improvement outcomes. To successfully map outcomes, it is necessary to define the path from solution planning to development to evaluation of solution results. Specifically, planning processes must be measured and mapped in terms of their efficacy in identifying solutions leading to the achievement of valued results.

Framework Elements

What Is Performance Analysis?

The analysis stage of most instructional system design process models is often misunderstood and neglected by both practitioners and potential "customers" of analysis. Rossett and Czech (1996) studied the practices of graduates of San Diego State University's Instructional Systems program and found that professionals in analysis and solution systems are often unable to use those skills because organizational leaders prefer a silver bullet approach to fixing problems. In a recent analysis designed by Branson, Kaufman, and Schaffer (2000), a large sample of U.S. Army training personnel and staff were surveyed regarding their use of the steps in the Systematic Approach to Training process model. The analysis step was considered to be the most important step (followed closely by evaluation) in the process, yet was completed the least. Reasons given for this were insufficient knowledge, time, incentives, or resources to complete the analysis, as well as a lack of clear expectations about the level of analysis desired. In addition, the term analysis is so misunderstood that there is widespread confusion about exactly what is to be analyzed, when, and by whom.

There are many variations on the HPT model, like the one in **Figure 3**, but all have the same basic components, and all begin with performance analysis. The major tasks of such an analysis are the following:

- Identify valued accomplishments of employees that will produce desired organizational results.
- Identify gaps between exemplary and typical performance or gaps between desired and current ability to seize opportunities.
- Analyze causes for those gaps.
- Identify and select solutions to close the gaps.

Some terms that are often used interchangeably with performance analysis are:

- Needs assessment (Kaufman, 1988)
- Needs analysis (Mager & Pipe, 1983)
- Performance assessment (Robinson and Robinson, 1995)
- Front-end analysis (FEA) (Harless, 1988)
- Training needs analysis (Rossett, 1999)

Within the field of human performance technology, the term performance analysis has become the general term for any of these types of analyses.

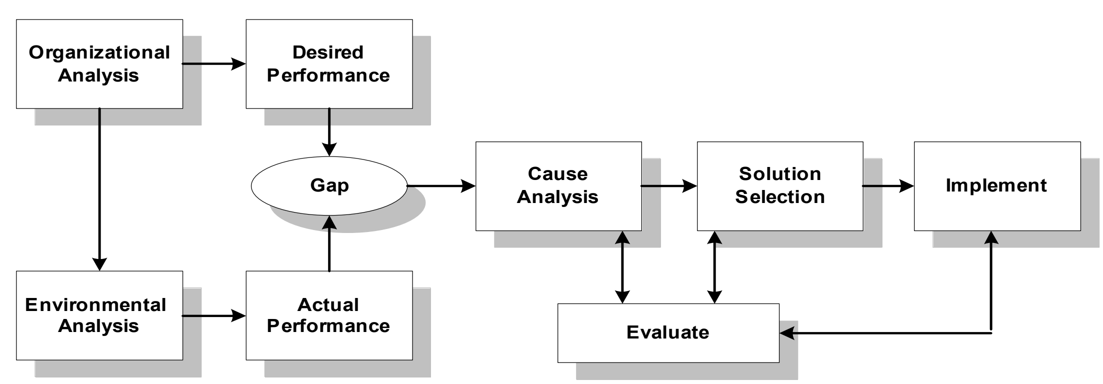

FIGURE 3: ADAPTATION OF THE INTERNATIONAL SOCIETY FOR PERFORMANCE IMPROVEMENT'S HUMAN PERFORMANCE TECHNOLOGY (HPT) MODEL

Ideally, performance analysis involves a partnering between the analysis team and stakeholders to define and achieve organizational goals. Solutions are based on what is learned, not on how business is typically done (Rossett, 1999). Performance analysis is used to describe what is happening, what ought to be happening, and what can be done to improve the current status of the organizational problem (Wedman and Graham, 1992). There are several types of performance analysis that have been identified in the literature and that are used in practice (Schaffer, 2000). These types of analysis represent a variety of views of the organization, ranging from the strategic level to specific individual processes, and thus differ widely in scope and purpose (*refer to Appendix B for a review of performance analysis frameworks*).

Organizational Performance System Views

Performance analysis is most effective if it is thought of as a linking of results and practices across the organizational system. Organizational system levels that we recommend exploring as part of the analysis are the strategic or organization level, the tactical or process level, and the individual performer-role or job level. While it is desirable to do a total and thorough system analysis prior to developing performance improvement solutions, such an analysis is often not within the scope of an analysis team. If this is the case, such a team may have access to previously generated strategic or mission analysis data that may be useful in linking results and practices across broad system levels as well as bounding the scope of the analysis.

The definition of a problem space in a complex organizational system requires knowledge of the system boundaries and structures. We propose to develop a performance analysis support framework that encompasses all three system levels: "Any analysis effort that does not address all three levels of performance is liable to produce only piecemeal results" (Rummler & Brache, 1995). While piecemeal solutions or "band-aids" are often easiest to implement, it is desirable to select and blend solutions from a system or strategic perspective to avoid adverse side effects at the other organizational levels.

Strategic/Organization Level

The strategic or organization level of analysis focuses on results necessary to achieve the vision and mission of the organization within the community, nation, or society in which it operates. An organization's vision is often translated into a mission statement and accompanying organizational results goals. A performance analysis team is interested in these outcomes and/or results and whether or not they are being achieved. Other levels of analysis will also be targeted and linked to accomplishment of results at the organization level.

Tactical/Process Level

The tactical or process level can be defined as the methods used to achieve both strategy and organizational results for the outputs of units. This level represents the linkage between the organization level and the individual performer level. Tactics/processes range widely and can be broad functional areas or discrete individual steps to complete a task. In business and industry, they are typically departments or divisions such as manufacturing, shipping, receiving, or accounting. In the military, tactics/processes may also be tied to specific platforms such as ships, tanks, or aircraft. Tactics/processes, and increasingly, knowledge, are the hidden assets of organizations. The competitive advantage of many organizations is based upon both the technical stability and innovativeness of their processes and the problem-solving capacity of their people.

The following is an example of how inefficient processes can impair the effectiveness of an organization. JC Penny is one of the largest retail chains in the United States. This organization is a major clothing supplier through its more than 1,000 nationwide stores and catalog sales. Sales associates were having difficulty handling product and inventory changes. Information could be obtained from individual stores' paper-based reference manuals (over 100 per store) and from mainframe terminal computers. Analysts found that manuals were often out of date and the computer system was extremely complicated to learn. "Trainers actually had to go into each store and sit down with employees to go through the entire system...a very time-consuming and labor-intensive process." The analysis resulted in a process redesign. An electronic performance support system was implemented. This system provided employees with specific answers and information when they needed it to perform their jobs. In addition, the system provided training when needed. The result of the redesign measurably enhanced worker productivity and competence (adapted from www.ispi.org).

Job/Individual Performer Level

This level examines the practices and products of the individuals who are performing a particular role or job. It is common to blame individual performers or a performance team (unit) when problems occur rather than to examine the entire performance system. A common approach to analyzing performance at this level is to develop a model of exemplary or excellent performance by observing and interviewing exemplary performers and their supervisors. Performance analysis often focuses on this level, and solutions are selected based on individual performance development requirements. Development of performer or job level capacity to learn and problem solve is crucial to an organization's ability to optimize processes and innovate.

Figure 4 depicts the relationships among the strategic/organization, tactical/process, and job/individual performer levels.

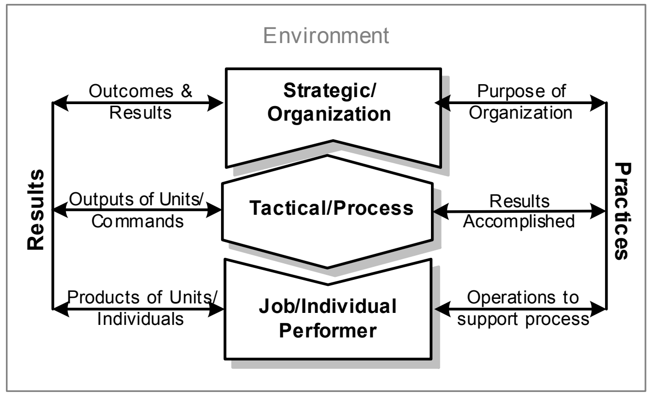

FIGURE 4: ORGANIZATIONAL SYSTEMS VIEW

Performance analysis is not a prescriptive, top-down, linear, or static approach. Rather, the analysis team may begin at any system level and through iterative cycles uncover information for each of the other levels. This focus on desired organizational and performance results will quickly focus the analysis within a specific performance area and avoid overly heavy analysis. The combined use of the visual performance models and collaborative analysis techniques to be described later in this paper will assist the analysis team in identifying, validating, refining, and tailoring analysis information that will be useful to solution designers.

Recommended Performance Analysis Approach

Analysis Triggers

There are generally two kinds of situations that trigger a performance analysis: a problem and an opportunity. Problems are often specific and include some indicator of poor performance, a change in normal operating procedure, or an inability to adapt to changes in the performance environment. Problems are often expressed in terms of a high error rate, low productivity, or increased accidents. Opportunities are often less specific and are associated with a desire to change the organization or an entire mission area or group of people. Examples of opportunities include: new performance required as a result of new systems or equipment acquisition, re-assessment of current training to determine effectiveness and relevance, and change in organizational or unit mission in response to competition or other pressures. The distinction between problems and opportunities is important. Problems require a focus on gaps between desired and current performance and ways to close such gaps. Opportunities require a focus on desired or expected performance and ways to support such performance.

The following is an example of a performance analysis conducted to accommodate a trigger for an opportunity. In 1987 the Coast Guard was acquiring new aviation equipment, HH-60J helicopters. Upon arrival, the new equipment would need to be integrated into the normal workload by both technicians and mechanics. Training would need to be conducted so that integration of the new helicopters could be done as quickly as possible. Coast Guard personnel were familiar with the maintenance of helicopters, but this particular model was new and different. Several other military organizations had courses on this new equipment, but evaluation of the courses proved that the content and length were excessive. Analysts conducted a front-end analysis to determine the project scope for this opportunity. A development team was established. This interdisciplinary team consisted of various stakeholders, subject matter experts, and designers. Training and job aids were developed. The analysis also helped create guidelines for managers concerning the necessary amount of support equipment each site should purchase. The result of this opportunity analysis was targeted courses that were significantly shorter than those offered by other agencies. Shorter instructional time resulted in a cost savings to the organization. (www.ispi.org)

For all practical purposes, the performance analysis process can be broken into three phases: *Define, Analyze,* and *Select*. These phases are not mutually exclusive; they often occur in iterative cycles. These phases consist of activities that focus the efforts of an analysis team on planning activities within an overall performance improvement system model. Planning activities are centered on the collection of data and information that bounds a problem or opportunity "space", focuses the analysis on results expected across organizational levels, and identifies gaps in performance and potential ways to address those gaps. Brief descriptions of each planning phase follow.

Define

The *define* phase of any performance analysis is absolutely critical because it plans, guides, and supports the rest of the analysis process. The *define* process begins with scoping activities to identify whether a problem or opportunity warrants a performance analysis. If the problem/ opportunity is deemed necessary, financial and non-financial costs are estimated and key stakeholders are identified. Stakeholders will help to determine the resources and sources of data that can provide information regarding the problem or opportunity gap at hand. The primary goals of this significant and extensive phase are to determine: 1) the desired organizational results and gaps upon which to focus the analysis, and 2) the individual performances or competencies necessary to accomplish the desired organizational results as well as the criteria on which these performances should be based. It is also important in the *define* phase to identify any obstacles or barriers to achieving the optimal performance.

Analyze

The *analyze* phase consists of identification of actual or "is" performance and comparison of that to the optimal or "should" performance. In problem analysis, a "diagnostic" or discrepancy approach is taken in which typical performers are compared to exemplary performers to identify performance gaps. Gaps between these groups of performers (actual vs. optimal) are analyzed to determine possible causes for the gaps. Three broad areas in which causes (or drivers) for poor performance are often found are lack of skills or knowledge; lack of motivation or incentives; and lack of tools, equipment, and processes (Harless, 1970). There are many possible drivers of human performance, but most fall into one of these categories (*refer to Appendix A for identification of potential drivers*). In opportunity analysis, the current performance environment is analyzed to determine the degree to which it supports desired performance, to identify ways in which the current organizational structure and environment can be leveraged to take advantage of the opportunity, and to establish how the current environment and processes must be changed. The goal of this phase is to identify gaps between actual and optimal performance results and/or competencies and to determine possible causes for these gaps. After possible causes for gaps have been identified, analysis team stakeholders analyze them further in an effort to clarify and narrow the number of possibilities. It should be noted that many current enhancers of excellent performance will also be identified during this process. Enhancers may be leveraged by the analysis team to make recommended solution blends more compatible with the organizational culture.

Select

The final phase in the proposed performance analysis process is the *select* phase. This involves selecting appropriate solutions based on the nature and type of causes as well as relevant drivers that have been identified during analysis. For example, training increases skill or knowledge, appropriate feedback increases motivation and clarifies expectations, and so on. High probability causes are linked to possible solutions that appear to be able to address these causes. Causes for gaps and enhancers of current performance are matched with solution types that each represents one of many elements of a total solution package. Solutions are then selected that are deemed most cost-effective, most feasible, and most appropriate given the organizational environment in which the problem is occurring. These solution types or strands are prioritized based on compatibility with current practices and organizational culture, availability of objects in the repository that may be reused during solution development, and cost. This process is closely linked to solution design, with requirements specification being the bridge between the two processes.

Figure 5 represents the three phases of analysis. As shown, a performance analysis team works collaboratively using a variety of templates, visual modeling tools, and processes to complete the analysis. Outputs of the process are stored in an analysis repository.

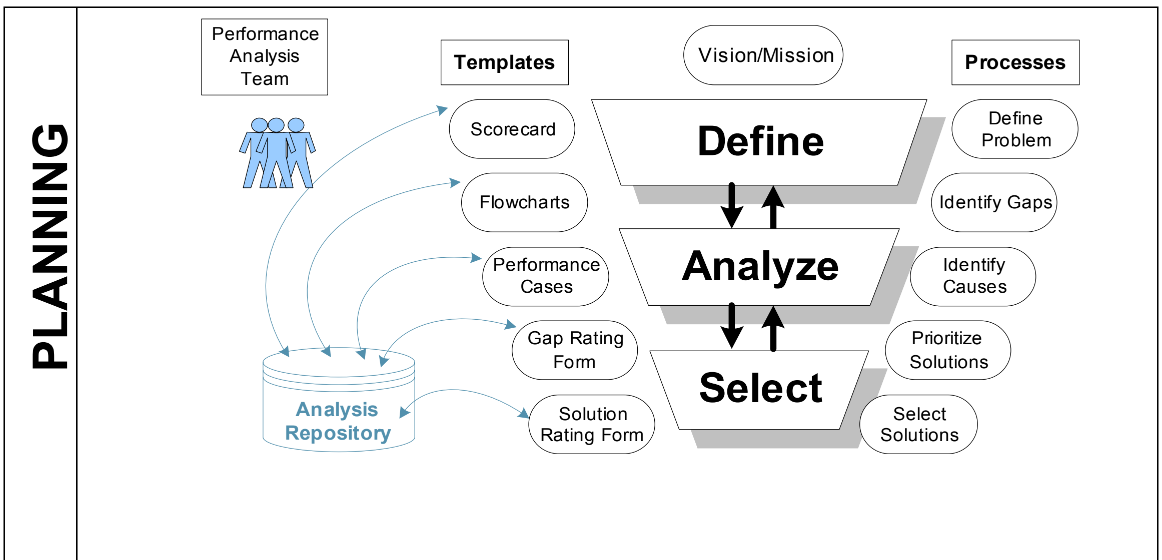

FIGURE 5: PERFORMANCE ANALYSIS APPROACH

Blended Solutions

The culmination of completing a performance analysis is the recommendation of solutions. Because there will be an assortment of causes for each organizational gap, there should also be a variety of solution recommendations and alternatives. The reason for this approach is two-fold: 1) blended solutions can be re-purposed to develop collateral materials that will assist the performer when transferring or applying solutions in the workplace, and 2) short-term as well as long-term solutions can be developed. By using blended solutions all the "bases" can be covered: "band-aids" are provided for quick and easily seen results, while more systemic or strategic solutions can also be implemented to avoid adverse side effects at the other organizational levels. If these systemic solutions are not included, the potential exists for a missed opportunity or an aggravated problem.

The following example illustrates how solutions are blended within an organization to solve a performance problem: Century 21, one of the world's largest real estate sales organizations, was having difficulty retaining newly licensed agents. Upon obtaining a real estate license, sales associates were unable to easily acclimate into a sales team. These individuals had difficulty obtaining their first listing and often became discouraged by the gap between the training offered and the working environment. The organization perceived the solution to this problem to be an in-house experiential training system. Analysts conducted a needs analysis, which included all stakeholders. They discovered that the novice sales associates did not perceive that they were receiving the same quality and quantity of support that experienced agents believed they were providing. Analysts determined new hire associates not only needed more training, but they needed a structured support system. The result was self-directed training in a variety of formats (print, audio, and video). Each office also created a "coach" or mentor from its experienced staff whose responsibilities included answering questions and providing necessary feedback. Questionnaires were developed to aid Century 21 in the selection of their office coaches, and a compensation package was provided to them because of their additional workload and responsibilities. As a result, 72% of the new agents obtained their first listings within 4 weeks, and 92% had theirs within 8 weeks – half of the time it takes an average realtor to obtain his/her first listing. Century 21 spent $2,000,000 on the analysis and program; however, it realized a 100% return on its initial investment. Yearly gross commissions for agents obtaining earlier listings generated $2,026,700 for the organization (www.ispi.org).

Object Orientation, Objects, and the Analysis Repository

The first element of the OOPA framework is human performance orientation. Now we turn to the second element and trend essential to this framework, object-orientation. Object orientation represents the next step in the progression toward using reusable objects to create performance improvement systems. When developing objects, it is not sufficient to have object-oriented technologies and standards alone; it is also necessary, while employing an object-oriented methodology and creating objects, to incorporate analysis and design thinking. By integrating object orientation and performance analysis, a higher level of reusability as well as adaptability, interoperability, and durability may be achieved. An object-oriented approach with a results focus applied to analysis, design, and implementation will make it easier to obtain, develop, and implement the solutions to organizational problems or opportunities.

What Is an Object?

Gibbons, Nelsons & Richards (2002), refer to a "learning object," "educational object," "knowledge object," "intelligent object," or "data object" as an "instructional object." However, since the focus of this framework is military performance, any learning, performance, or instructional object is referred to as a sharable content object (SCO), taken directly from *SCORM* v. 1.2.

The SCORM defines a SCO as "a set of representations of media, text, images, sounds, web pages, assessments objects, or other pieces of data that can be delivered to a Web client" (SCORM 1.2). A single representation, according to SCORM 1.2, is called an asset. A single asset is unusable in an educational/performance setting, but by conjoining these assets, a shareable content object is created. A set of shareable content objects is referred to as content aggregation. Content aggregation consists of "a map (content structure) that can be used to aggregate learning resources into a cohesive unit of instruction, to apply structure, and to associate learning taxonomies" (SCORM 1.2).

For an object to be SCORM compliant, it must meet specific criteria. Any object developed for performance/instructional purposes must be accessible, interoperable, durable, and reusable. "Without them [the criteria], anyone with a significant investment in either content or a learning system is locked in to that particular content or system" (Robson, Eduworks, 2001).

To ensure that the criteria exist within an object, meta-data is "tagged" to each asset, SCO and/or content aggregate. Meta-data is tagged to an asset, SCO, and content aggregate to ensure that during the process of content creation, the information within each is reusable as well as discoverable. By integrating meta-data from the basic asset level, content aggregation will be fully accessible, durable, interoperable, reusable, and available to a repository as a "whole, autonomous unit" (SCORM v.1.2).

Why Are Objects Important Within the Framework?

The reasons for using objects are simple: they enhance the resulting solution package, provide methods for standardization, offer potential economic advantages through reuse, and promote collaborative work. The purpose of the OOPA framework is to provide a structure to carry out a performance analysis so that a variety of performance improvement solutions can be recommended for a performance problem or opportunity. The use of objects supports that aim by bringing together two perspectives that use a system approach: human performance technology and object orientation. The OOPA framework describes how organizations can apply object thinking not only to the construction of objects, but also to the analysis and design phases.

There has been a recent and growing emphasis on objects within the fields of instructional design and performance technology. Peters (1995) states "... objects enabled by [an] emergent artifact of digital libraries will be much more like 'experiences' than they will be like 'things,' much more like 'programs' than 'documents,' and readers will have unique experiences with these objects in an even more profound way than is already the case with books, periodicals, etc." This statement leads Gibbons, Nelson, and Richards (2001) to suggest the need for "model components that can be brought together in various combinations to create the environments and systems" to represent a variety of problems. OOPA creates a framework to implement these ideas. The OOPA framework will use object-oriented analysis techniques to provide an analysis team with tools that support performance system analysis processes.

The OOPA framework combines performance analysis and object orientation in a sequential process. The analysis repository provides the analysis team with support throughout the analysis process while the content object repository has the potential to provide designers with solution packages that match the recommend solutions generated by the performance analysis.

Overall, objects play a very important role within this framework. They not only serve as a guide but provide both the analysis team and designers with value "that in most cases will pay off many times over (in terms of costs, development time, and learning [and performance] effectiveness)" (Longmire, 2001).

What Is the Analysis Repository and How Will It Work?

The purpose of the analysis repository (**Figure 6**) is to support an analysis team doing performance analysis by providing a centralized location for the storage and reuse of standard analysis artifacts and objects. An analysis artifact generally refers to any template, documentation, data, visual model, or component of a visual model that can be accessed and used during any phase of the performance analysis process (*define, analyze, or select*). It is anticipated that standard documentation formats and modeling notations would be set for such artifacts. We envision that interlinked analysis artifacts will exist for the three levels of performance analysis (organizational, process, and individual) and that at the individual level, models will be refined to the extent that analysis objects can be identified. An analysis object will contain specifications for the support requirements of a specific performance case, which will enable early identification of content objects that may be useful in the construction of the solutions identified in the *define* phase.

The analysis repository will enable any analysis team to reuse existing artifacts and analysis objects that may have similarities to their own performance problem or opportunity that they have been tasked to analyze. In turn, analysis objects and artifacts themselves may be contextualized, customized, and/or updated to become new analysis objects. The purpose of providing users with the analysis repository is to create an easier, adaptable, and reusable analysis process. This process would also support the development of organizational problem-solving capacity and ultimately link to the identification of solutions. Creating a common standard for analysis artifacts and objects will enable the sharing of information about common problems or opportunities across different organizations.

In summary, an analysis repository supports reuse within analysis in a way similar to that in which a content repository enables reuse in construction. Analysis repositories also have the potential to support a highly contextualized search of the Content Repository, potentially increasing the efficiency and quality of design/development products. Analysis objects represent the link between performance analysis and the design of performance and learning support. In this way, analysis objects represent the specification for some of the constituent parts of the performance support system. Given that analysis objects are likely to encode some performance measures, they can be used to evaluate the chosen or constructed systems that are designed to meet these specifications. In this role, analysis objects help measure the return on investment of the solutions that are developed.

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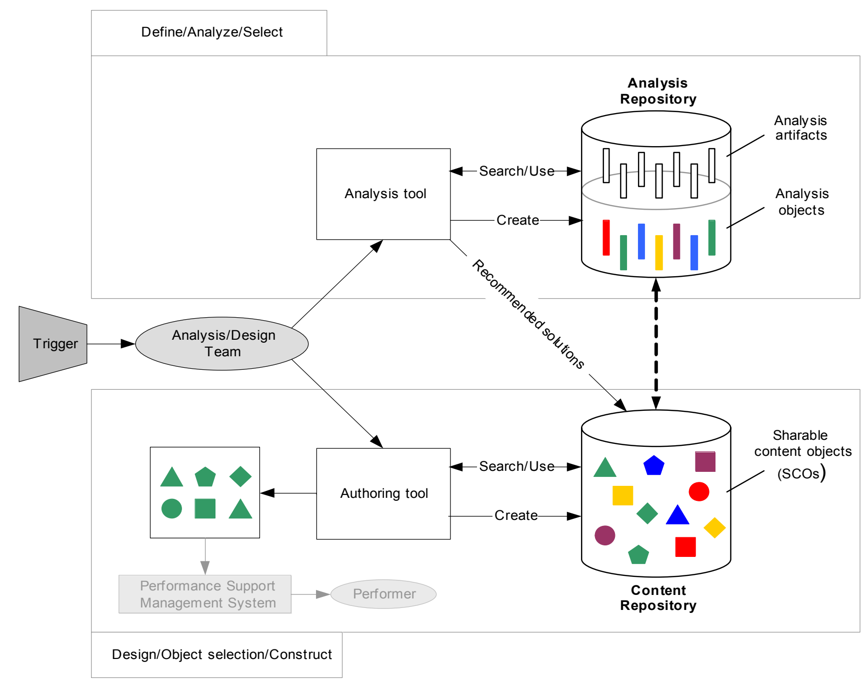


FIGURE 6: THE USE OF OBJECTS AND REPOSITORIES IN ANALYSIS AND DESIGN

Figure 6 illustrates the use of objects and repositories in performance analysis and design. Given a trigger event, the analysis team initiates a performance analysis process. An analysis tool would search the analysis repository for analysis artifacts that stakeholders could use in the define/analyze/select process. When the analysis team has created an analysis artifact, they save it to the analysis repository. The analysis team may also extend existing analysis artifacts by refining them to a more detailed level, adding new performance data, and identifying analysis objects.

Analysis objects are used to search for matching content objects in the content repository. These SCOs are the building blocks for solutions recommended by the analysis team. Using an authoring tool, the analysis team combines existing SCOs or creates new ones (which are saved to the content repository) to develop customized performance improvement packages for performers. Ideally, parts of this process would be automated: matching of analysis objects to SCOs, packaging and sequencing SCOs, and just-in-time delivery of performance support to users.

Features of the Object Orientated Performance Analysis Framework

In addition to our focus on performance analysis and object orientation, we recommend three features for which some form of automated support should be provided:

- Collaborative analysis
- Rationale management
- Visual modeling

These features are important to the OOPA framework because they help pave a path from an expert approach in performance analysis and object orientation to a more participatory approach.

Collaborative Analysis consists of a group of analysts and design experts, subject matter experts, and end-users/performers working collectively to plan/organize a performance analysis as well as working together to formulate and reuse objects.

Rationale Management requires performance analysts to use a cogent process to make their decision making clear. It discourages decisions that lack objective judgment or ones that do not have clear justification. Rationale management also produces the kind of historical project record required for asynchronous work, whether the interval is a few hours or a few years.

Visual Modeling will drive the design and construction processes. Visual modeling also connects to performance modeling, which visually represents the gaps found while analyzing individual performance.

Our goals for incorporating these features into the framework are, respectively, that all those involved in the performance analysis process will be able to participate effectively and efficiently, to have a clear concept of why decisions are made, and to visually perceive what is being done.

Collaborative Analysis and Design

No person can be an expert in every field, and the complexity of many tasks makes independent work impractical. Complex problems therefore require collaborative work teams that combine the training and experience of many. Through collaboration, individuals with complementary skills and diverse experiences create outputs and attain results beyond those of any one analyst working alone. In the context of this project, stakeholders operate as a team, achieving a common purpose by contributing individual resources and leveraging different perspectives. Effective collaboration creates these recognized benefits:

- Increasing access to information
- Identifying and capitalizing on individual expertise
- Providing a greater variety of perspectives
- Improving organizational processes through lessons learned
- Broadening the range of expertise
- Pooling of resources

A Model for Collaborative Performance Analysis and Design

Figure 7 below illustrates the role of collaboration in performance analysis and design. Given a trigger event, the analysis team initiates a performance analysis process. Having collected quantitative and/or qualitative data, the analysis team creates a visual model of the relevant elements of a performance system, using a standard notation system. Users and/or external experts work with the analysis team to refine and validate the model. Based on its collaboration with users and external experts, the analysis team continues to iteratively refine the model until it accurately reflects the performance issue, at which point the team is ready to enter a "building" phase.

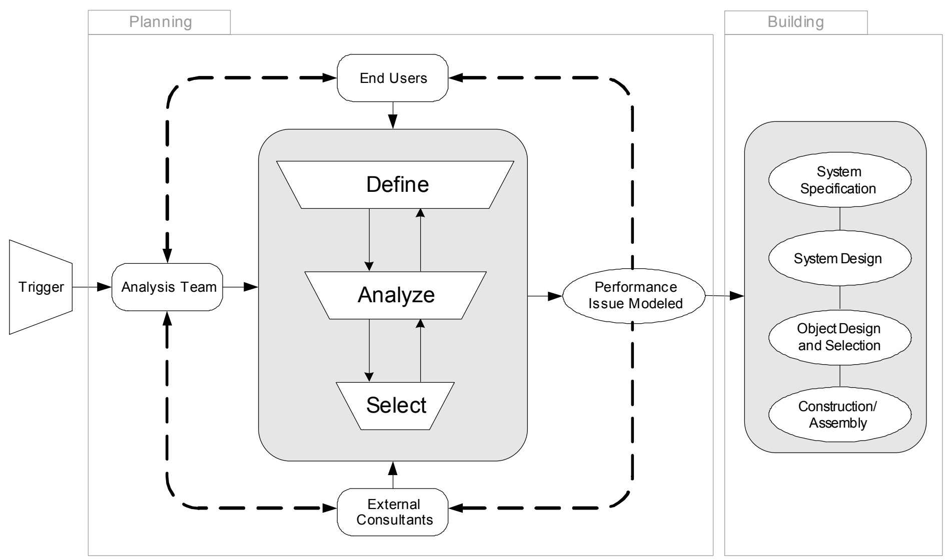


FIGURE 7: THE ROLE OF COLLABORATION IN PERFORMANCE ANALYSIS AND DESIGN

Supporting Collaboration Within Expert Work Teams

Effective collaboration for analysis and design requires that the organization do the following:

- Develop and equip internal experts
- Create roles for external consultants that complement and supplement the work of internal experts
- Facilitate shared responsibilities and meaningful communication among internal and external personnel

Table 1 lists some characteristics of internal and external experts.

External Experts	Internal Experts
Can take a fresh look at the program	May have "blind spots"
Tend to be more objective	Tend to be more subjective
Trained and experienced in evaluation methods; trusted as "expert"	May not be trained or experienced specifically in evaluation method
Outsiders who may not understand the program or the people involved	Familiar with and understand the program; can interpret presenting issues, personal behavior, and attitudes
May cause anxiety; staff and participants not sure of goals or motives	Known to the program, poses less threat; recommendations may appear less intimidating
May not have time to learn background and organizational culture thoroughly	Knows the history, what has been tried, and what is culturally acceptable
Able to evaluate solutions based on research and range of experience	Able to evaluate solutions based on knowledge of environment
Typically absent after consultation; follow-up limited	Can follow up after the intervention; able to encourage action because they will have learned the issues along the way

TABLE 1: COMPARISON OF INTERNAL AND EXTERNAL EXPERTS

As Table 1 implies, a team which combines internal and external experts compensates for each group's weaknesses and maximizes their strengths.

The OOPA framework allows for elements that support collaborating teams such as:

- Asynchronous work
- Rapid prototyping
- Sharing of data through templates
- Visual modeling
- Iterative design based on stakeholder review
- Tracking of decision history and rationales

Encouraging Broad Participation of Stakeholders

Recent trends (e.g., high performance work organizations) have emphasized broader participation in analysis, research, design, and evaluation by all stakeholders in a particular project or program. High performance work organizations involve the workforce as a partner in all levels of decision making and value the knowledge and insights of front line workers. In the context of the current project, participation can be defined as a process by which stakeholders assume increased and broader levels of responsibility for work issues in which they have experience and expertise. Emphasis on end user analysis and usability testing in software engineering is an example of broadening stakeholder participation in design and evaluation. Broadened participation requires that the organization make choices about levels of participation and roles participants will play to accomplish project goals.

The analysis team must guide and shape the degree of participation and roles or functions of participants. They may involve participants as sources of data, interpreters of data, designers, planners, facilitators, and evaluators. **Table 2** lists collaborative activities typical for performance analysis.

Performance Analysis Phase	Collaborative Activities
Define	• Establish scope • Identify sponsors • Identify stakeholders • Identify required resources • Outline required data • Create data collection plan • Conduct/participate in interviews, focus groups • Identify organizational results gaps • Identify individual performance results • Identify best practices/competencies • Map desired organizational and individual results
Analyze	• Conduct/participate in interviews, surveys, focus groups • Interpret data collected • Identify gaps • Identify causes
Select	• Identify potential solutions • Rate potential solutions • Rank potential solutions • Design solution package • Design action plan

TABLE 2: COLLABORATIVE ACTIVITIES

For each of these participant roles, a range of involvement is possible. It should be obvious that participation is a question of degrees, not an either/or decision. It can take a number of forms and dimensions. To implement this collaborative model, internal analysts must (1) view participants from all levels of the organization as experts in what they do who have valuable insights and (2) understand that performance issues exist within a system that involves networks of people, processes, and technology situated in the context of an organizational environment.

Incorporating Expert Tools

Software design and instructional systems design provide examples of expert tools that codify methodology, capture expertise, and institutionalize best practices through software applications. These tools enable stakeholders and content experts to fill roles once reserved for design specialists. Since expert consultants seldom understand intricate problems the way stakeholders can, the most effective work may be done by a collaborating team equipped with expert tools (*Some examples of expert tools can be found in Appendix C*).

Expert tools are software applications with intrinsic performance support features that capture the cognitive processes of experts on a given task or job. These performance support features may include agents, wizards, context-sensitive help, tutorials, integrated database access, intuitive navigation, guiding questions, feedback for self-evaluation, and automation of tasks. The OOPA framework will guide users through an object-oriented performance analysis process using the following strategies:

- Multiple entry points into process
- System view of organization
- Analysis heuristics
- Graphical overviews of process
- Step-by-step guidance
- Expert advice
- Forms and templates

Because the tool will be driven by work goals, it will support work tasks rather than simply provide resource information. The benefits of this performance-centered design include immediate productivity for novices who are unfamiliar with analysis and design methodologies, an enhanced collaboration among novices and experts, and meaningful input from a wider variety of stakeholders.

Rationale Management

When participants are separated by time and/or space, knowing what project decisions have been made and why they were made generally improves collaborative work. Otherwise, stakeholders who were not a part of the decision making process will exhaust time and energy trying to piece together the reasons behind decisions. Therefore, documenting and providing the rationale behind decisions should be an integrated process. Rationale management is a process that captures the reasoning behind system design (Brice & Johns, 1999). It can also provide documentation of what decisions were not made during the design process and why (Burge, 1998). The design rationale of an artifact or object can be documented in a variety of ways, ranging from formal design specifications to informal notes found in the notebooks of the designers themselves (Burge, 1998).

Why Use Rationale Management?

According to Karsenty (1996), rationale management is used for recycling previous designs, synchronizing work on an extensive project, supporting essential reflection during design, and assisting with the maintenance and use of the object. In other words, documenting the rationale behind an artifact or object can keep the analysis team and designers on the same page and focused on the same objectives. Documentation provides each stakeholder with a clear understanding of all decisions made during the analysis process, whether or not he/she was personally involved.

The potential for object reuse is increased when the practice of rationale management is embedded into the analysis process. The analysis team can rely on decisions made by other successful projects (via the analysis repository) to guide the current project towards success. Providing rationale can help contextualize how the objects were previously used and therefore increase proper object selection.

Decisions and lessons learned from one project can educate others. Any given project might dictate a change in membership of collaborative groups; documentation of past decisions will provide incoming members with necessary historical project background. New team members will benefit from a complete understanding of the project and will be able to contribute more effectively. Often the design team is not included in the analysis process; providing designers with documentation of analysis decisions will help them to produce appropriate solutions.

Integrating Visual Modeling

In collaborative analysis and design, it is crucial to understand and represent the perspectives of the different stakeholders who have an interest in the process. This project therefore advocates approaches using modeling schemes that are accessible and useful to both analysts and designers. Representations of a performance system and specific interventions must be not only understandable (readable) by a diverse group, but constructible (writeable) by the stakeholders themselves.

Sierhuis and Selvin (1996) write that “modeling reduces complexity by creating categorization and order through which people can create meaning, in order to get a shared understanding, which allows them to communicate.” Modeling also creates abstract representations of concrete systems that serve as a filter, removing irrelevant information. In short, effective models facilitate discussion among stakeholders, helping them reach consensus on key fundamentals and work toward common goals. Sierhuis and Selvin maintain that a successful modeling approach requires (1) a well-defined modeling framework that provides for structure and project management, as well as techniques that can be applied within the framework and (2) a useable design tool that prevents users from being overwhelmed by the complexity of modeling. Finally, they describe the criteria for any methodology used to perceive a problem situation or system and to construct models:

- **Create meaning:** Verbal language is often not enough to share meaning with others. Modeling is a tool to create shared meaning through external conceptualization. A methodology should include a modeling technique for creating external representations that reflect meaning created by the participants.
- **Shared understanding:** The external conceptualization (i.e., the model) allows a group to share the creation of meaning. A methodology should include tools and techniques that mediate and nurture this scaffolding process.
- **Create structure:** Structure is important to the creation of meaning and shared understanding. A methodology should include a framework that can be used as guidance in the modeling process. Such a framework helps in creating a domain ontology that is consistent and understandable.
- **Communication:** A shared domain ontology (i.e., the model) allows people to talk about the domain without ambiguity and confusion. A methodology should include a technique for modeling in such a way that it can be used in conversation.
- **Reduce complexity:** Very often complexity is a result of existing ambiguity. Modeling helps to solve ambiguity and, therefore, reduce complexity. A methodology should include a modeling method that will reduce the complexity of the problem situation.

Sierhus and Selvin (1996)

Creation of Visual Models

There are many methods for showing the interrelationships between business levels and processes; however, some of these methods are not very visual in nature. These "non-visual maps" are typically used during craft-type analysis. In such maps, textual information is often too difficult for novice participants to "see" the system and its interactions or to universally interpret the nuances in the language. This problem can be solved by creating visual models such as pictorial representations. Standard pictorial representations of an organization, interactions, or goals contribute to a unified understanding of a particular meaning that could often be supplemented by a textual description.

To standardize visual modeling, unified modeling language (UML) will be used. UML has primarily been used in object-oriented software development, but it has also been adapted for business processes and enterprise business modeling (Marshall, 2000). UML is designed to facilitate communication in a visual manner throughout a project's duration, and to ensure that participants have a clear understanding of the system and its components. UML includes eight different diagram types for modeling a system. Each diagram type illustrates a different view of a system. There are two types of UML diagrams that can be used with slight modifications to help analysts to visualize performance modeling: 1) Use cases can be adapted to model the individual performer level, and 2) activity diagrams can be used to model the process/tactical level.

Visual models should be used at each of the performance levels to help with the analysis process. Completed models and model components become artifacts that can be stored in the analysis repository; these will be available to be reused and repurposed in the future. Analysts will select the appropriate diagram type for a particular performance level. For example, at the strategic/organizational level, analysts will be able to use either the balanced scorecard or the performance relationship map (*see Appendix D)* to refine information and focus on an appropriate process to use at the tactical/process level. The tactical/process level focuses on how work is completed; modeling on this level can be accomplished through flow charting or activity diagrams. The operational/individual performer level should use performance cases (an adaptation of UML use cases) to capture necessary information.

Performance Case Modeling

Performance case modeling is a combination of the typical non-visual methods that performance analysts use and the visual modeling method of the use case. Performance cases provide a visual method for determining gaps at the operational/individual performer level. Ellipses which are normally called use cases will now be referred to as performance cases. These performance cases represent a performance goal. Use cases also include actors, that is, humans or computer systems which interact outside system boundaries. Performance cases will refer to actors as performance roles; they are abstract role responsibilities that can be achieved by anyone with the proper knowledge and skills; additionally, performance roles represent performers working within system boundaries.

Performance case models can provide a framework for examining required or "should" performance during the *define* phase using information obtained from exemplary performers and their supervisors. Each exemplary performer will provide analysts with a scenario, that is, specific information on how to perform a given task. The "should" performance cases will be abstracted from several exemplary scenarios. "Should" performance cases may be created from the best practice methods necessary to achieve a performance result as identified by the exemplary performers. "Is" performance cases may be developed based on scenario abstractions obtained from the typical performers. The documentation for each performance case will provide the foundation for identifying the resources necessary to achieve performance support for the case. The performance case documentation will help analysts determine the barriers to achieving optimal performance. These barriers help classify the performance problems by causes and potential solutions, which help analysts develop recommendations to close performance gaps.

The UML concept of a package is used to collect related performance cases into a meaningful unit. The performance cases within packages will usually represent high level performance goals. A high level performance case can be refined into a more detailed model with performance packages that represent the sub-goals of the parent package.

Case Study and Example of Performance Modeling

To illustrate the visual modeling process, we have used the After Action Review "How to Plan, Rehearse and Execute a Prep by Echelonment" from the Center for Army Lessons Learned. (Pritchard and Harris, 2002). We are incorporating the information obtained from the analysis and not the analysis process. This After Action Review contains information at the individual job level; we have added the higher performance levels solely for illustrative purposes. We realize the information is most likely inaccurate, but we believe this illustrates one of the flaws in non-collaborative model development.

In the project's analysis, it is presumed that the goal at the strategic/organizational level is to minimize casualties of ground troops through the optimal use of long range weaponry. Such a goal would require the examination of processes involving the use of long range weaponry. For purposes of illustration we have created a model of the general process required for mission planning and execution (see **Figure 8)**. The model shows a flow between separate stages of the process, and that the planning process is composed of at least two sub-processes. One of the sub-processes relates to the creation of a plan for the use of long range weapons to support a mission. This is the process referred to above; it is this process that we will model at the individual performer level.

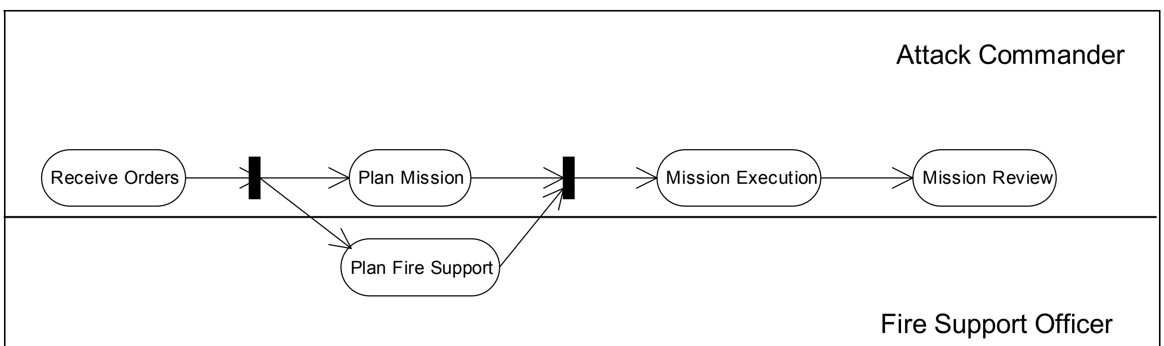


FIGURE 8: GENERAL PROCESS FOR MISSION PLANNING AND EXECUTION

The performance package for creating a fire support plan is illustrated in **Figure 9**. Performance cases show how a high level performance goal can be broken down into a number of sub-goals, and how supporting job roles are associated in the achievement of the performance result. Documentation of the performance cases can allow the capture of performance measures and the knowledge and skill requirements. The stick figures are performance roles used to represent the interaction with the system. A performance role is not a particular person or job title, but an abstract role responsible for achieving some performance result. The ellipses represent the performance results and show the linkage between the performance roles and the system. The ellipses are connected to documentation of information that would help analysts categorize performance barriers, thus facilitating proper solution selection. Packages will be created for related performance cases, which represent an identifiable subsystem within a larger system.

In Figure 9, the main performer in the system is the fire support officer (FSO). This is an abstract entity, and although the task will normally be performed by someone with a given job title and rank, it may be performed by anyone with the necessary knowledge and skills. According to the After Action Review, to achieve the goal of creating a fire support plan, the person in the performance role must achieve a number of goals using identified best practices. Each of these best practices requires interaction with one or many (indicated by an asterisk) representatives of other performance roles. There may be performance cases that come into play in special circumstances (e.g., special planning for the use of smoke); these would be indicated using the <<extends>> relationship.

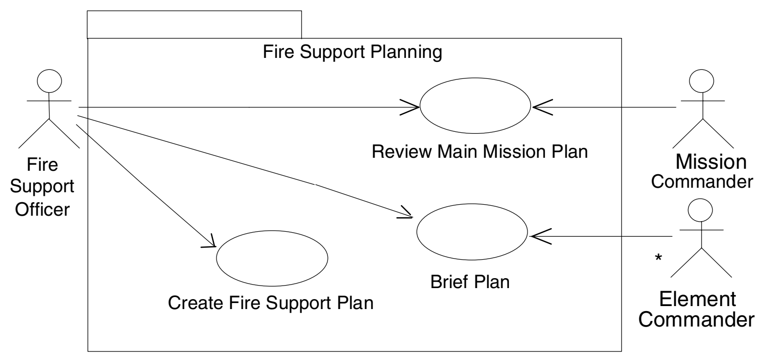


FIGURE 9: PERFORMANCE CASE PACKAGE FOR FIRE SUPPORT PLANNING

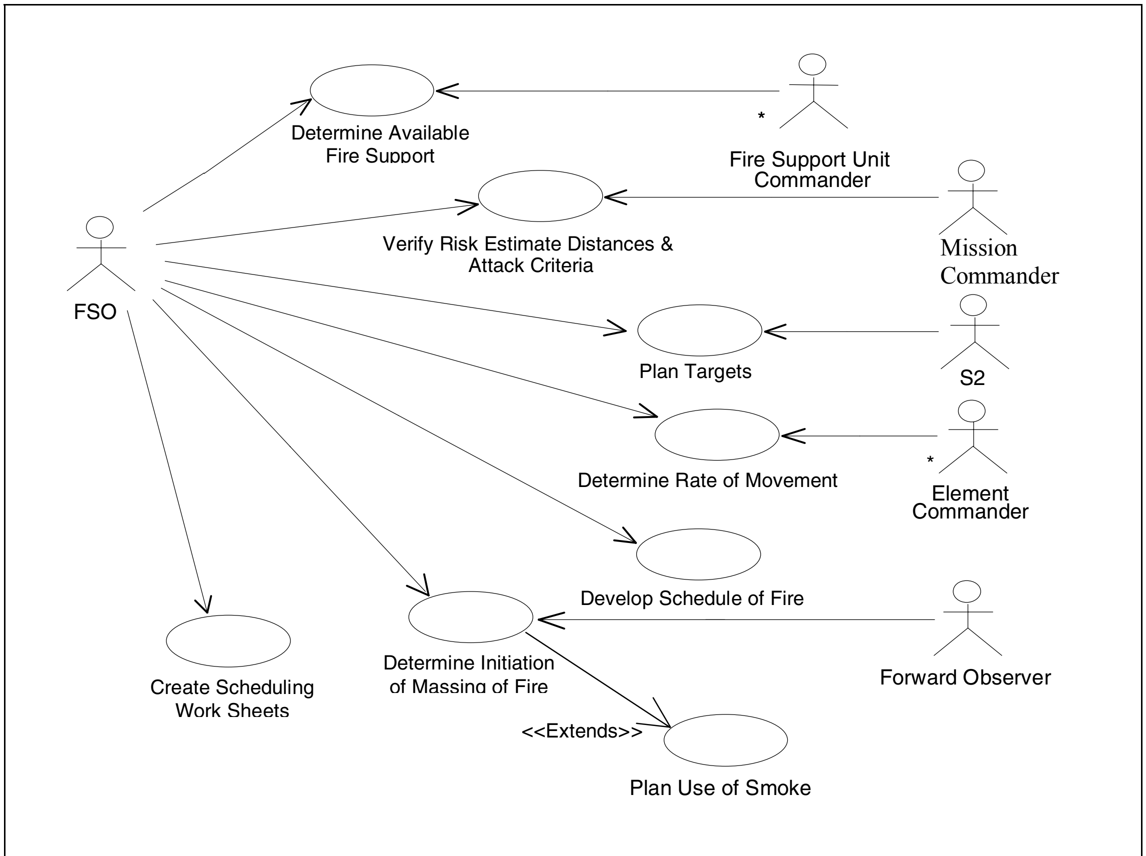


FIGURE 10: A REFINED PERFORMANCE CASE MODEL FOR "CREATE FIRE SUPPORT PLAN"

Figure 10 represents a high level view of the performance goals; the diagram allows for immediate identification of the best practices as well as the collaborations between performance roles. The next step would include documentation for the performance case involved in the identified gap in performance. The following is the important performance-related information that should be included in the documentation:

- A description of the performance result and linkage to strategic/organizational result
- The interaction of other performance roles
- The requisite knowledge and skills required by the performance roles relevant to this performance case
- Performance measures that identify standard and exemplary levels of performance

In addition, other information that may be linked to each performance case includes the following:

- Existing task analyses
- Cognitive models
- Detailed study of exemplary performers

The textual documentation (see the example in **Figure 11**) would focus on the various barriers to optimal performance. Analysts would use a standard template for this documentation. Completion of this information would help analysts classify performance problems and specify object solutions. The information in Figure 11 is based on the After Action Review. However, the document did not include this data; it was fabricated for the purpose of illustration. A gap was identified for the performance case “verify estimated distances and Attack Criteria.” In this example, the analyst chose the Performance Pyramid (*Appendix B*) to determine the necessary resources to achieve this best practice.

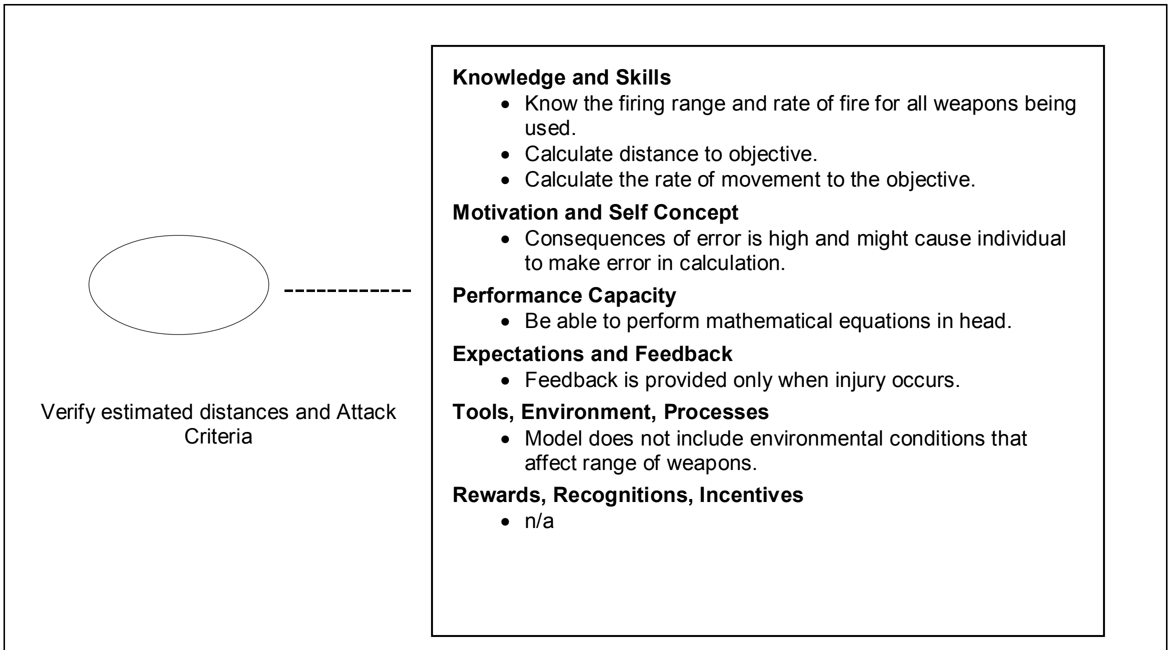


FIGURE 11: AN EXAMPLE OF TEXTUAL DOCUMENTATION

It should be stressed that the creation of the models is an on-going collaborative process. These models are not meant to result in each performance case’s being refined and documented to the lowest level. The identified gap in performance will guide the refinement process for the models. We have argued that reuse is as important in analysis as it is in construction. A standard system for modeling together with a repository for analysis models and documentation would mean that over time, higher level models would pre-exist to be reused in analysis. Comprehensive and evolving performance models for the whole organization would emerge. This would enable the analysis of problems of similar roles and performance goals to be reused within and across organizations.

Conclusion

The OOPA framework is founded on a basic problem-solving approach that is distinctive in its integration of object orientation and features such as collaborative analysis, rationale management, and visual modeling. Performance analysis is essential because it has the potential to uncover problems and enhance opportunities that exist within an organization. By linking performance analysis to object orientation, the recommended solution package is enhanced through a built-in filtering system. It provides methods for standardization throughout the analysis process. Most importantly, integrating the OOPA framework creates a great potential to increase the cost-effectiveness of learning and performance support systems through sharing of previous analysis work and the facilitation of reuse of previously developed materials and resources.

Figure 12 represents the vision of the OOPA framework as well as the link between the planning phase of performance analysis and the design and the construction phase. It is our intention that by successfully defining a framework for object performance analysis, solutions to organizational problems or opportunities will be clearly specified, resulting in a building/construction phase that will take less time and make optimal use of existing reusable resources to achieve the ultimate goal: supporting individual performers and strengthening learning and performance experiences.

The next stage of this project involves a number of activities. First, we will further refine the framework presented in this document by subjecting it to review. Second, we will augment the framework by developing heuristic guidelines for analysis teams. Third, we will investigate and document the requirements for automated tools to support the framework. Fourth, we will develop proof-of-concept prototypes for the tools and the analysis repository. Finally, we will evaluate the refined framework and prototype tools by further field testing on an analysis project.

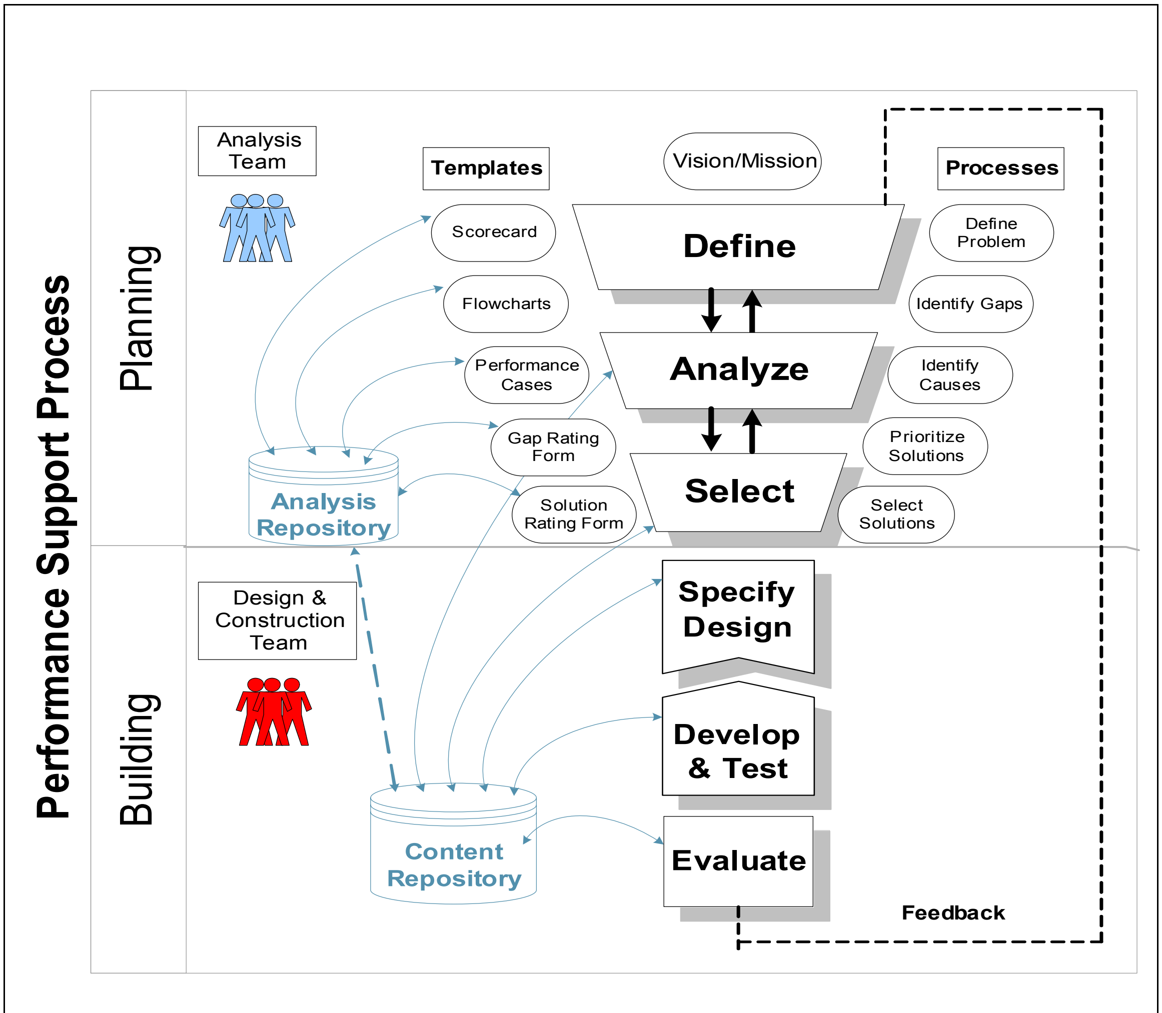


FIGURE 12: OBJECT-ORIENTED PERFORMANCE SUPPORT PROCESS MODEL

References

Branson, R., Kaufman, R. and Schaffer, S. (2000). Systems Approach to Training: Proposed process enhancements. *White paper for The Deputy Chief of Staff for Training Headquarters, TRADOC*, September 1.

Brice, A. & Johns, B. (1999). *Improving design by improving the design process: A DRAMA white paper.* Enviros Software Solutions.

Burge, J. (1998). *Design Rationale Types and Tools.* AI in Design Group, Computer Science Department, WPI. http://www.cs.wpi.edu/Research/aidg/DR-Rpt98.html

Cameron, J. (2002).Configurable Development Process (Vol. 45, No. 3) pp. 72-77. Communications of the ACM.

Cioffi, J. & Markham, R. (1997). Clinical decision-making by midwives: managing case complexity. *Journal of Advanced Nursing*, 25, 265-272.

Cox, B.J. Planning the Software Industrial Revolution November/December 1990 (Vol. 7, No. 6) pp. 25-33 IEEE Software magazine http://www.virtualschool.edu/cox/CoxPSIR.html

Dickelman, G.J. (2000). EDIT 797: Performance-based design [Online], http://pcd-innovations.com/EDIT797/id98_m.htm

Douglas, I. & Schaffer, S. (2001). A methodological framework for an object-oriented performance support system. http://www.lpg.fsu.edu/OOPA/projDescription.asp

Due, R.T., (2002). Mentoring Object Technology Projects. Upper Saddle River, NJ: Prentice Hall PTR.

Gibbons, Andrew S., Nelson, Jon, & Richards, Robert. (2002). The Nature and Origin of Instructional Objects. In Wiley, David A. (ed.), *The Instructional Use of Learning Objects* (pp. 25-58). Bloomington, Indiana: AIT/AECT

Gilbert, T. (1996). *Human competence: Engineering worthy performance* (Tribute Edition). Amherst, MA: HRD Press, Inc.

Gordon, J. and Zemke, R. (2000) The attack on ISD. *Training*, April. Retrieved online, November 1, 2001 http://www.trainingsupersite.com/publications/archive/training/2000/004/004cv.htm.

Harless J., (1970). *An ounce of anlaysis (is worth a pound of objectives)*. Newnan, GA: Guild V Publications.

Harless, J (1988). *Accomplishment-Based Curriculum Development.* Newnan, GA: Harless Performance Guild.

Huselid, M.A. (1995). The impact of human resource management practices on turnover, productivity, and corporate financial performance. *Academy of Management Review*, 38(3), 635-672.

International Society for Performance Improvement (ISPI) Website: ispi.org

Kaplan, R., & Norton, D. (2001). *Five principles of the strategy-focused organization.* Balanced Scorecard Collaborative Web Site: http://www.bscol.com/

Karsenty, L. (1996). *An Empirical Evaluation of Design Rationale.* Association for Computing Machinery, Inc. http://www.acm.org/sigchi/chi96/proceedings/papers/Karsenty/ lk_txt.htm

Keegan, D. (1996). Foundations of distance education. (Third ed.). London: Routledge.

Kuipers, B, Moskowitz, A.J. & Kassirer, J. P. (1988). Critical decisions under uncertainty: representations and structure. *Cognitive Science*, 12, 177-210.

LOM-Learning Objects Metadata Working Group. http://ltsc.ieee.org/wg12/

Longmire, W. A Primer on Learning Objects http://www.learningcircuits.org /mar2000/ primer.html

Marshall, C. (2000). *Enterprise Modeling with UML: Designing Successful Software through Business Analysis*. Reading, MA: Addison-Wesley.

Perez, R. and Emery, C. (1995). Designer thinking: how novices and experts think about instructional design. *Performance Improvement Quarterly*, 8(3), 80-95.

Peters, P. E. (1995) Digital Libraries Are Much More Than Digitized Collections. Educom Review, 30 (4), July/August. www.ed ucause.edu/ pub/er/review /reviewArticles/30411.html

Raybould, B. (2001). Performance support engineering: building performance-centered web-based systems, information a systems, and knowledge management systems in the 21st century. Performance Improvement, 39(6).

Robson, R. (2001). All About Learning Objects. http://www.eduworks.com/LOTT/ tutorial/learningobjects.html

Robinson, D. and Robinson J.C., (1995). *Performance Consulting: Moving Beyond Training*. San Francisco: Berrett-Koehler.

Rossett, A. and Czech, C. (1996). They really wanna, but….the aftermath of professional preparation in performance technology. *Performance Improvement Quarterly,* 8 (4) pp. 115-32.

Rossett, A. (1999). *First Things Fast: A Handbook for Performance Analysis*. San Francisco: Jossey-Bass Pfeiffer.

Rummler, G. & Brache, A. (1995). *Improving performance: How to manage the white space on the organization chart* (2nd ed.). San Francisco: Jossey-Bass.

Sarasvathy, D.K, Simon, H. & Lave, L. (1998). Perceiving and managing business risks: differences between entrepreneurs and bankers. *Journal of Economic Behavior & Organization,* 33, 207-225.

Schaffer, S. P. (2000). A review of organizational and human performance frameworks. Performance Improvement Quarterly, 13(3) pp. 220-243.

SCORM v 1.2 http://www.adlnet.org/

Senge, P. (1990). *The Fifth Discipline: The art and practice of the learning organization*. New York: Doubleday.

Shadbolt, N. & Wielinga, B. (1990). Knowledge based knowledge acquisition: The next generation of support tools. In B. Wielinga: J. Boose; B. Gaines; G. Schreiber; & M. Van Somerau (Eds.), *Current trends in knowledge acquisition*. Washington, D.C.: IOS Press.

Sierhuis, M. and Selvin, A. (1996). Towards a Framework for Collaborative Modeling and Simulation. NYNEX Science & Technology Technical Memorandum.

Sveiby, K. E. (1997, December). *Intangible assets monitor.* Karl-Erik Sveiby Library Web Site: http://www.sveiby.com.au/IntangAss/CompanyMonitor.html

Wedman & Graham (1992). *Performance improvement: Using the performance pyramid.* Training Program Analysis & Design in Columbia, MO.

Appendices

Appendix A: Major Frameworks

Appendix B: Performance Drivers

Appendix C: Tools

Appendix D: Examples of Analysis Templates

Appendix A: Major Frameworks

The OOPA Framework will include a combination of performance models and performance frameworks. These differ in that frameworks typically provide analysts with a structure to guide the analysis process, while models provide assistance for the implementation of the analysis. The models are prescriptive, while the frameworks provide a more descriptive type of support. It is common to use a combination of performance frameworks and performance models to provide direction to a project (Schaffer 2000).

By using both models and frameworks, the Army analyst takes a holistic approach to organizational analysis. With several frameworks and models to use, analysts can choose those most appropriate for solving their organizational problem or opportunity.

Human Performance Framework

Performance frameworks are intended to be generic components that identify the relationships within an organizational system. Generality is the goal of performance frameworks because they are designed to be the "starting point for performance assessment, diagnosis, or analysis of organizational problems or opportunities" (Schaffer, 2000, p. 222).

Correctly using the performance frameworks is critical for identifying the linkage between the organization level and the processes within the performance environment (Schaffer, 2000). Thus, performance frameworks allow analysts to strategically link actual practice to the organizational mission/goals. According to Schaffer (2000), frameworks are used for the following reasons:

- To visually communicate the concept of performance improvement to the client
- To frame discussion of organization components to be analyzed
- To guide the selection of assessment, analysis, and evaluation
- To identify key structures, forces, and relationships impacting organization effectiveness
- To define strategic results criteria to be accomplished

The frameworks chosen for this project are some of the major human performance frameworks in current use. Each of the following frameworks is used to accomplish a different goal:

- Rummler & Brache's Nine Performance Variables
- Gilbert's Behavioral Engineering Model
- Wedman & Graham's Performance Pyramid
- Sveiby's Intangible Assets Monitor
- Kaplan & Norton's Balanced Scorecard

Rummler and Brache's Nine Performance Variables

Rummler and Brache's framework is designed to aid in the creation of a graphical representation of an organization. This framework provides analysts a series of questions to help document the various organizational functions from the organization level, through the process level, and down to the individual performer or job level. One of the main goals of this framework is to identify the relationships between organizational inputs and outputs. An analyst using this framework would be capable of visually documenting organizational disconnects between the various levels.

Gilbert's Behavioral Engineering Model

Gilbert's framework was one of the first developed. This framework assists analysts with describing relationships between behaviors, accomplishments, and performance. Gilbert defined these ideas in terms of the individual performer or employee and the working environment. A behavior can be classified as what is done on the job by an employee. An accomplishment is the output produced, and performance is the combination of them. (Schaffer, 2000) This framework helps identify performance that is critical for the organizational objectives. Gaps are identified when different goals appear between the various organizational levels. (Schaffer, 2000)

Wedman & Graham's Performance Pyramid

The Performance Pyramid is designed to focus attention on the individual performer. This framework assists analysts by isolating organizational elements that affect performance, such as an employee's knowledge and skill level, motivation, capacity, and tools available. The simplicity of this framework is one of the key reasons for its wide use; analysts can show the linkage between an organization and the individual based on three simple factors: "a vision, a support system consistent with the vision, and financial resources adequate to fuel the support system" (Schaffer, 2000).

Sveiby's Intangible Assets Monitor

The Intangible Assets Monitor is designed to focus on the strategic level of an organization. This framework links employees' assets (such as knowledge) to the overall organizational mission. The purpose for measuring these "hard to measure" intellectual property assets is that it will help an organization discover where additional improvements should be made and where organizational strengths lie, thereby determining how the organization can function at a higher level of proficiency. This framework examines the following: assets both external and internal; employee competence; employee stability; and employee efficiency. The framework is not intended to be prescriptive and all indicators do not have to be included within an organizational analysis. An organization would choose to utilize the elements which suit its needs and wants.

Kaplan & Norton's Balanced Scorecard

The Balanced Scorecard is designed as a method for ensuring that the organizational strategy and the individual performer are in alignment. This framework should be used as a communication tool for the employees, increasing understanding of how their performance contributes to the overall success of the organization. In fact, the Balanced Scorecard can also be used to clarify the organizational vision as well as put it into action. The process for completing this method is iterative and helps visually establish cause and effect relationships from the organizational strategy down to the performance level. This framework focuses on four elements: clarifying and translating the vision and strategy, strategic feedback and learning, planning and target setting, and communicating and linking.

Reference:

Schaffer, S. P. (2000). A review of organizational and human performance frameworks. Performance Improvement Quarterly, 13(3) pp. 220-243.

Appendix B: Performance Drivers

Rossett identifies four "drivers" or categories of requisite factors that impact performance and links these drivers to an array of solutions. While the lists below are not exhaustive, they do illustrate how analysts move from performance gaps to a set of appropriate performance interventions that analysts must evaluate and rank before constructing an action plan.

Type of Driver	***Description***	***Solutions***
Lack of skill, knowledge, or information	People don't . . . because they don't know how, or they've forgotten, or there's just too much to know.	• Education, training • Information support (job aids) • Documentation, performance support • Coaching, mentoring • Clarity regarding standards • Communication initiatives
Weak or absent motivation	People don't . . . because they don't care, don't see the benefit, or don't believe they can.	• Education, training • Information support (job aids) • Documentation, performance support • Coaching, mentoring • Participatory goal setting • Communication initiatives
Ineffective environment, tools, and/or processes	People don't . . . because processes or jobs are poorly designed or because necessary tools are unavailable.	• Reengineering work processes • New or improved tools or technologies or work spaces • Job design or redesign • Job enrichment • Participatory decision making
Ineffective or absent incentives	People don't . . . because doing it isn't recognized, doing it is a hassle, or not doing it is ignored.	• Improved appraisal and recognition programs • Management development • New policies • New and shared goal setting

Reference:

Rossett, A. (1999). *First Things Fast: A Handbook for Performance Analysis*. San Francisco: Jossey-Bass Pfeiffer.

Appendix C: Tools

The following software tools were identified as being potentially useful in supporting aspects of this analysis framework. The next phase of this project involves research into automated analysis, including the construction of proof-of-concept prototypes. iThink, eThink, and ePlan all include features that are relevant to these prototypes, but no one of these applications alone is sufficient to fully support the framework described in this document.

iThink

The iThink software, developed by Barry Richmond of High Performance Systems, Inc., is a tool for constructing shared understanding and awareness across an organization. The underlying purpose of iThink is to visually represent systems thinking (as described by Peter Senge in *The Fifth Discipline*), providing a methodology for the development and examination of organizational models, processes, and problems. "Its simple language of stocks, flows, and rates and the simple icon driven software allows managers to build systems and produce graphic and tabular output that enables the examination of changed inputs and structures" (http://www.surf.net.au/linchpin/iThink.html).

eThink

eThink® "offers a new way to leverage technology, critical thinking processes, and information, rapidly transforming them into accessible knowledge and business results" (Kepner-Tregoe, 2001). Not to be confused with iThink, eThink serves as a problem-solving agent that "makes knowledge accessible and reusable, while creating a continual springboard for competitive advantage and business success" (Kepner-Tregoe, 2001). eThink incorporates key features that are important to the framework described in this document as well: collaborative thinking, just-in-time learning, and reusable knowledge (objects). Benefits of eThink include improved quality of organizational problem solving skills, day-one performance, and organizational creativity.

ePlan

ePlan, developed by Florida State University's Learning System Institute for the U.S. Navy, is a web-based planning and analysis support tool for performance consultants. The tool guides analysts through the analysis phases of *define, analyze,* and *select* by systematically starting at the organization level and funneling down to the individual performer level to find performance results gaps. A cause analysis results in a solution set that is specifically designed to optimize performance effectively and with the most efficient use of resources. Some of ePlan's key features include a portal for creating analysis reports that guide planning and analysis processes, support for team collaboration, and a community of practice to support continuous improvement.

References:

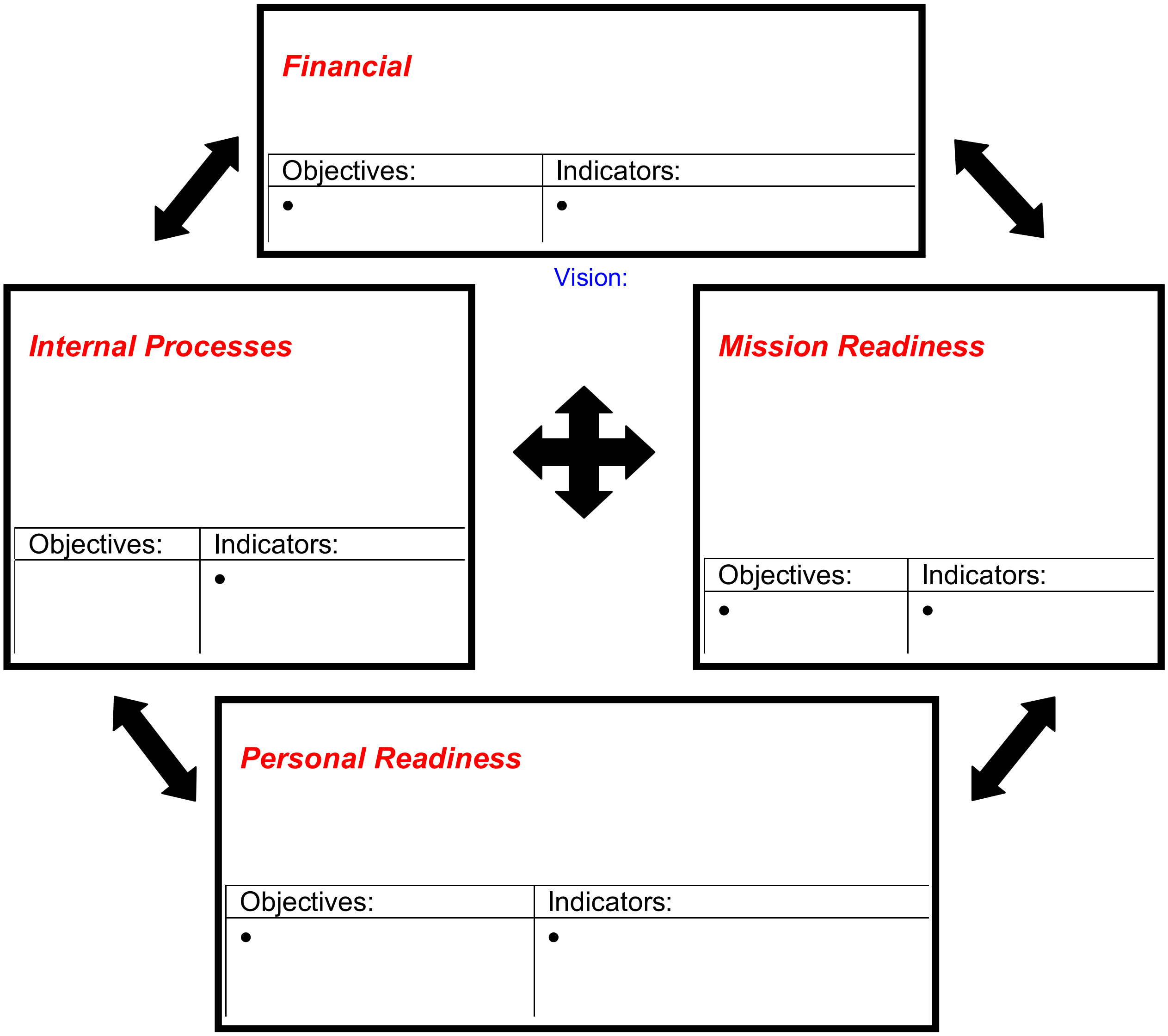
ePlan, Learning Systems Institute www.lpg.fsu.edu/eplan

eThink, Kepner-Tregoe http://www.kepner-tregoe.com/ethink/

iThink, High Performance Systems, Inc *http://www.hps-inc.com/*

Appendix D: Examples of Analysis Templates

Balanced Scorecard



Performance Relationship Map

The Performance Relationship Map, developed by Dana Gaines Robinson and James C. Robinson, is a map that illustrates the interrelationships between important aspects of human performance such as business goals, performance requirements, and training and work environment needs.

Organizational	**Individual**
Desired Results (SHOULD) *The organization has business and organizational goals.*	Desired Results (SHOULD) *On-the-job performance requirements are established for employees to ensure that organizational goals are met.*
Organizational	**Individual**
Current Results (IS) *Current performance is yielding current organizational results.*	Current Results (IS) *This indicates the current or actual performance of employees when compared to the "should".*

Glossary

Adaptability – tailoring of learning/performance support content to individual and situational needs

Analysis artifact – any documentation, data, visual model, or component of a visual model that can be accessed via the Analysis Repository and used during any phase of the performance analysis process (*define, analyze, or select*)

Analysis heuristics – mental shortcuts or rules of thumb that enable analysts to make judgments and decisions quickly and easily

Analysis objects – containers of specifications for the solution support requirements of specific performance cases. Analysis objects assist the development of object-oriented performance solutions by providing solution designers with targeted information describing the problem or opportunity and by potentially suggesting related SCOs

Analysis repository – a centralized location for the storage and reuse of standard analysis artifacts and objects

Analyze phase – the phase of a performance analysis process in which actual performance (current performance or the "is") and desired performance (optimal performance or the "should") are identified and compared

Asset – sharable resource or raw media file, as specified by SCORM

Collaborative analysis – performance analysis that is done by a team of individuals with complementary skills and diverse experiences to create outputs and attain results beyond those of an analyst working alone

Configurable methodology – a methodology based on agreed upon and sharable work products, but flexible regarding the methods used in the construction of those products

Content aggregation – the process of aggregating SCOs/assets into a defined content structure to build a useful instructional or performance support resource

Content object repository – a container for assets and SCOs which designers use to construct instructional or performance support resources

Define phase – the planning stage of the performance analysis process in which the analyst clarifies the problem/opportunity and identifies the desired organizational and performance results

Drivers – factors that positively impact performance

Durability – property of an object by which it does not require modification as versions of system software change

End user analysis – process of discovering characteristics of a performer who is a direct consumer of the solution package

Enhancers- strengths within an organization that are leveraged during an opportunity analysis

Exemplary performers – individuals who are meeting the performance results and specific criteria that the system has defined

Expert tool – a software application with intrinsic performance support features that capture the cognitive processes of experts performing a given task or job

Framework – a shell comprised of generic organizational components that identifies major elements and relationships within an organizational system

Gap – the discrepancy between the optimal (*should*) and the actual (*is*)

Human performance technology (HPT) – the systematic approach to improving productivity and competence

Individual performer (job level) – the level of an organizational system at which individuals perform a particular role or job

Interoperability – the capability of an object to operate across a wide variety of hardware, operating systems, and Web browsers

"Is" (actual) – current performance at an organization, process, or performer level

Learning taxonomies – classifications of levels of intellectual behavior important in learning

Meta-data – literally, *data about data*; descriptive information attached to objects used to ascribe semantic meaning to reusable digital resources. It enables contextualized, efficient searches of content and analysis repositories to identify relevant objects.

Modeling Notation- the textual or graphical symbols and rules used in constructing a model. For example, in  musical notation the symbol is used to represent a half note.

Notation system – a standardized graphical language for describing, defining, and documenting a system or parts of a system

Object-oriented – an approach that promotes greater cost-effectiveness and larger ROI in system development by maximizing the reuse of existing and newly created materials

Outcome – results of goods or services having been produced

Output – quantity of goods or services produced

Performance case modeling – a combination of the typical non-visual documentations that performance analysts use and UML use cases

Performance role (actor) – an abstract role responsible for achieving a performance result

Performance analysis - the process by which analysts partner with clients to identify and respond to opportunities and problems and to find an appropriate solution blend

Rationale management – a process of capturing and documenting what project decisions were made and why they were made. As part of the object-oriented approach to system design, it maximizes internal reuse of the project process.

Reusability – property of objects that allows them to be modified and used repeatedly by tools or projects different from those in which they were created

Sharable Content Object Reference Model (SCORM) – a model that references a set of interrelated technical specifications and guidelines designed to meet the Department of Defense's high-level requirements for Web-based learning content

Select phase – the phase of the performance analysis process in which stakeholders choose solutions based on the nature and type of causes as well as relevant drivers

Sharable Content Object (SCO) – a collection of one or more assets that include a launchable asset that uses the SCORM Run-Time Environment to communicate with a Learning Management System

"Should" (optimal) – the desired performance at an organization, process, or performer level

Solution blends – An array of interventions that, when strategically combined, address the range of problems/opportunities discovered in the performance analysis process and cause performance improvement

Stakeholder – an individual or a representative of a group that is impacted by a performance problem or opportunity

Strategic or organizational level – the level that focuses on the results necessary to achieve the vision and mission of the organization

Tactical or process level – the level at which strategic and organizational results are achieved and outputs are realized

Tagged – a term that describes an object to which meta-data has been attached

Trigger – any event or situation that causes initiation of the problem-solving process

Use cases – models describing the behavior of a system from an actor's point of view. In this context, an actor is defined as a performer or member of a system that has some goal or input within the system.

Visual modeling – creating and using graphical representations to clarify and communicate the structure and behavior of a system or part of a system