Performance Support Systems: Guidelines for System Design and Integration

William D. Milheim

Abstract: With the Increasing availability of computer technology for a variety of job-related tasks, many organizations are turning to electronic performance support systems for the provision of information, decision-support, and training for on-the-job employees. The present article describes the components of thesesystems (advisory support, information base, learning experiences, and applications software) and provides suggestions for their design, development, and use,

Resume: L'usage grandissant des technologies electroniques dans les taches reliees au travail a amene un grand nombre d'organismes a se tourner vers les systemes de soutien Informatique pour l'apport d'information, le support decisionnel et la formation du personnel deja en poste. ['article qui suit decrit les elements constituants de ces systemes de support consultatif, de bases d'information, de program mes d'apprentissages et de logiciels d'application et offre des suggestions en ce qui a trait a leur conception, leur developpement et leur utilisation.

INTRODUCTION

Over the past several decades, instructional technology has allowed educational institutions and corporate organizations to increase their efficiency and effectiveness through the use of well-designed instructional materials delivered in a variety of different media formats. In education, the focus for this utilization of technology has evolved from the use of large group media (film, videotape, etc.) to the implementation of individualized learning (computer-assisted instruction, slide-tape programs, etc.). In the corporate world, technology has traditionally been used as a support mechanism for stand-up training, typically involving videotapes and slide usage. These media are also changing in some companies to the use of more complex technologies such as interactive video and other forms of multimedia.

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Changes such as those described above are to be expected, since instructional technology itself has changed significantly over the past several years, through decreasing costs and increasing capabilities for many technological options. Computer-based training, for example, would not have been a possibility for many instructional tasks only ten years ago, simply due to the high costs and expertise required for its use. This situation has obviously changed radically within the last several years.

One of the most recent innovations in instructional technology involves the use of performance support tools, defined by Puterbaugh (1990c) as software designed to improve worker productivity by providing immediate, user-controlled access to integrated information, learning opportunities, and expert help. While such systems are not purely instructional by definition (because they may provide learning opportunities as only one component of their overall design), they do have the potential for making excellent use of available technologies and increasing user satisfaction and effectiveness on specific job tasks. Because system design is obviously of critical importance to its effective use, the present paper will focus on the appropriate design of these performance support tools.

Rationale for the Use of Performance Support Systems

In the past, traditional training programs have been used to provide knowledge, skills, and new information to employees working in a corporate environment. Training programs, while potentially effective, have proven to be somewhat inefficient because only a certain portion of what is taught in the classroom is actually remembered by the participants, with an even greater loss of information when a delay occurs between instruction and actual application on the job (Puterbaugh, 1990b). Training costs are also becoming prohibitive due to increasing costs for instructors, travel to and from training events (Courseware/ Andersen Consulting, 1990), and lost employee work time for formal classroom sessions and complicated course structures (Horn, 1989).

The complexity of many of today's jobs also requires skills in numerous, interrelated content areas with over-lapping job responsibilities. While traditional training techniques can address each of these areas individually, it is difficult to design educational exercises that will simulate the actual, complex work environment as it will be viewed by employees as they perform their work assignments. In essence, it is difficult to provide employees with all the skills they will need in their work setting in advance of their actual placement in that environment.

A number of other problems related to employee access to information within an organization are described by Raybould (1990b). These include:

- problems accessing relevant information without being overloaded by non-relevant data;
- determining how to quickly find answers to specific questions;
- ensuring that users are accessing the most up-to-date information;
- allowing for different knowledge levels within users; and
- acquiring knowledge when needed, rather than in pre-scheduled training sessions.

Each of these areas can be particularly problematic when traditional training techniques are used in those organizations with large amounts of required or requested information.

The use of performance support, on the other hand, redefines how a company prepares and supports its employees' performance, by making resources and information available to people on-the-job instead of merely providing this data during off-the-job training sessions. Based on these requirements, such systems merge computer and information technologies to provide employees with training, reference, and expert advice on their own desktop computer terminals (Horn, 1989). These systems combine existing technologies with new performance models and allow the integration of learning experiences into the job itself, much like historical mentoring and apprenticeship programs (Puterbaugh, 1990b).

According to Wolman (1989), these tools allow the user to control the way that needed information is obtained (e.g., sequence, medium, level of explanation) and offer the spontaneity and individualization of on-the-job training or coaching without demanding another person's time. Gery (1989b) adds that such systems allow less experienced and knowledgeable people to be assigned more complex tasks, because the organization can leverage the knowledge of its experts to such personnel through this type of system.

In addition, performance support systems address potential problem areas including information overload, the need for easy access to information and training, geographic dispersion of employees, and the need for accurate, timely, up-to-date information (Raybould, 1990b). The use of performance support, however, requires a change in thinking from merely providing training events to the overall provision of information and support in the context of the job itself (Puterbaugh, 1990b).

While there is a strong rationale for the implementation of performance support systems, there are also significant barriers that must be overcome before employers and employees can take advantage of this new technology. Puterbaugh (1990b) lists a number of these barriers including:

- the small number of personnel in training organizations advocating new approaches or perspectives;
- the infancy of the performance support movement, which results in a lack of experienced practitioners, development models, procedures, and tools;
- difficulties comparing development costs for performance support tools with the benefits to be gained by their use;
- weak organizational links within an organization which may be insufficient to effectively assist in the design of a performance support tool;
- the lack of significant problems with the current state of affairs within training organizations; and
- the current methods typically used for measuring training output (number of student days spent in training or the number and diversity of various courses) — methodologies which do not fit performance support goals for minimizing the amount of time spent in learning situations.

Geiy (1989b) adds several other obstacles to the potential utilization of performance support systems. These include the probable shift of subject matter expertise from a person with the content knowledge to someone with both job knowledge and learner understanding as well as the lack of organizational reward for change.

Each of these barriers can, to some degree, inhibit the growth of performance support systems within a company or organization. However, knowledge concerning each factor and how it can potentially affect the design and use of such systems will assist the potential developer in obtaining company and employee support for the development process of these useful tools.

Components of a Performance Support System

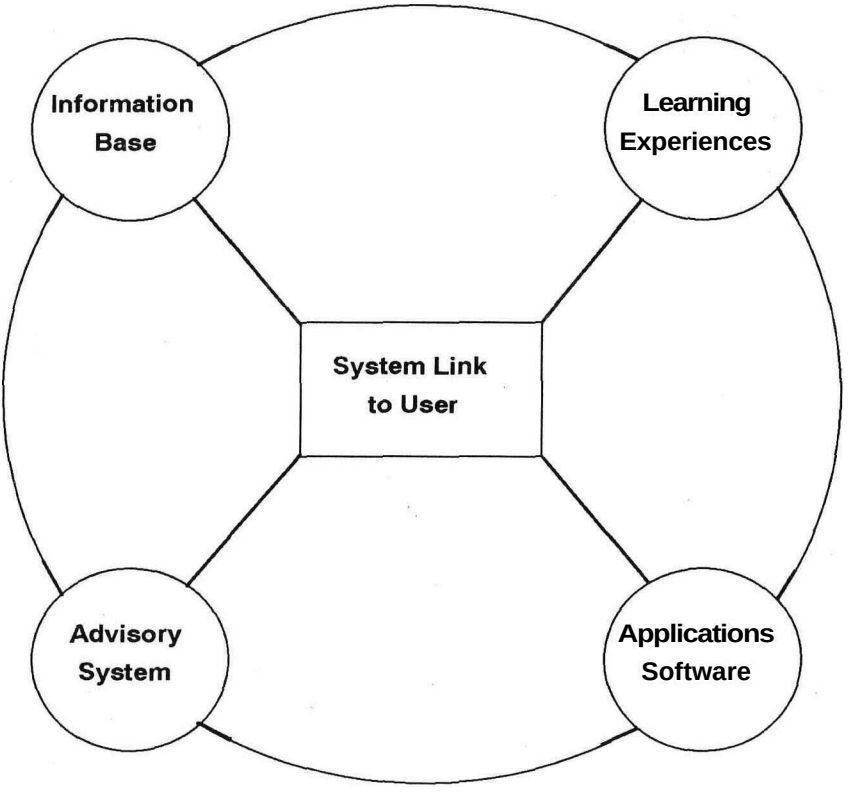
One of the most comprehensive definitions for a performance support system is stated by Gery (1989a, 1989b) who describes this type of system as an integrated, easily accessible environment structured to provide individualized access to information, software, guidance, advice, assistance, data, images, tools, assessment, and monitoring systems, which allow employees to perform their jobs with minimum of support from others. The Courseware/Andersen Consulting Company (1990) describes additional elements for a performance support system including systems reference, competency profiles, and company policies and procedures.

In general, such systems typically consist of three or four major components including: an advisory system to provide advice on task performance or decision-making, an information base that gives access to the information required to perform a certain job, learning experiences which can be linked to the information and advisory components whenever useful, and applications or productivity software, if available (Raybould, 1990b). Figure 1 provides a description for the design of a performance support system utilizing these components.

The advisory component of a performance support system is often composed of an expert system which assists the user in making decisions by asking questions and then providing recommendations based on rules that emulate human expert decision-making (Puterbaugh, 1990c). These "computerized experts" provide customized advice to each worker on demand and can include items such as troubleshooting, training path determinations (Courseware/ Andersen Consulting, 1990), assistance in problem structuring, and decision support analysis or diagnosis (Gery, 1989a).

This advisory component should be designed to take the place of a human coach or expert and should provide step-by-step assistance to the user, who may not have an in-depth understanding of the currently required task (Raybould, 1990b). As an intelligent job aid, this component can lead a user through an interactive session to solve a specific problem, while the computer keeps track of user responses and makes inferences based on its internal representation of the situation. Raybould (1990b) also suggests the use of multiple, small, task-specific expert systen; modules that can be linked to the document currently in use.

Figure 1.
Performance Support System Design



The second component, the information base, can be described as interactive documentation that includes the necessary information applicable to the performance support system, often structured in a hypertext or hypermedia format, which allows the user to navigate through the information in any order and to any depth (Puterbaugh, 1990c). This component can also include an on-line, field-specific help system; an integrated reference system organized around specific work requirements; and a section including system updates, system enhancements, new product announcements, etc. (Courseware/Andersen Consulting, 1990). Horn (1989) adds that such systems can also contain "company standard" knowledge (information and rules that have already been approved by the company) which allow employees to make quick decisions based on pre-approved knowledge.

Gery (1989a) describes this component as a data base that holds all the information that the user will need to use or manipulate in doing a job. She adds that this information can include:

- traditional data bases with numbers, libraries, and other data;
- text data bases including items such as procedures, policy and product information, specifications, business policy, glossaries, memos, and so forth;
- visual data bases with libraries of pictures, schematics, diagrams, graphics, maps, and full motion video;
- audio data bases with libraries of sounds and music; and
- information services such as the Dow Jones News Retrieval.

Each of these information formats would be of obvious assistance to employees based on the task being conducted at a particular time.

Since this type of data base can be quite large, retrieval techniques for locating information are very important. Raybould (1990a) describes two different methods to allow users to retrieve information from an electronic performance support system — query-based and browsing-based. According to Raybould, query-based techniques commonly include searching for text strings within the data base; however, this technique can have somewhat limited results because even expert users often find less than 80 percent of the available information, with other users experiencing "hit rates" as low as 20 percent.

The second type of information retrieval, browsing-based, can include retrieval types such as:

- associative retrieval (e.g., hypertext) which is particularly appropriate for ill-defined problems, exploring new task domains or for audiences with varying knowledge requirements;
- hierarchical outlines, similar to a book's table of contents, which can be useful for providing the user with an overview of the system; and
- manually-constructed indices, where connections among different information components may be different for each index.

In addition, Raybould suggests combining associative retrieval with other techniques when the information resides in very large, hypertext data bases.

The next component, the learning experience, also performs a valuable task within a performance support system through its ability to provide computer-based training "on-demand" while being tailored to the requirements of the worker's current or projected job (Courseware/Andersen Consulting, 1990). Raybould (1990b) suggests that this experience should focus on higher level learning skills such as problem-solving or simulations of the work environment, because facts and concepts are already present in the information base. Gery (1989a) adds that this component can be interactive and permit self-directed or structured learning experiences initiated by the performance support system or by the user.

Puterbaugh (1990a) provides several specific suggestions for the design of the computer-based training component within a performance support system including the elimination of elaborate conversational responses, the inclusion of a mouse interface for user control, and some means for proceeding without direct response by the user. Puterbaugh also suggests the provision of an escape route at any point from the computer-based training portion of the system and not requiring a separate sign-in for this section.

Assessment procedures may also be designed into the training component of a performance support system to permit the evaluation of knowledge or skills either before or after actual task performance (Gery, 1989a). These procedures can take the form of test questions, case problems, or simulations, which permit the user to determine whether certain knowledge or skills have been acquired (Puterbaugh, 1990a).

The fourth component, applications or productivity software, could include word processing programs, spreadsheets, data bases (Courseware/Andersen Consulting, 1990), communications packages, desktop publishing programs, or other software needed by the user in the course of a normal workday. Each of these applications should be readily accessible, with data easily exchanged among the various software packages. In addition, the control structure for each program should be similar, so that valuable training time will not be wasted while the user learns how to use each software package.

Integrated Component Design

While each of these components is critical to the overall effectiveness of a performance support system, it is the interface between components and the links to the user which provide the employee with the tools to display information, advice, etc. Without appropriate integration, the system will not be able to quickly or easily provide the required assistance to the person requesting system support.

Overall, each component should be available whenever needed in the form required by each user request. There should be a consistent, easy-to-use system interface within each module (Gery, 1989a), allowing the employee to move almost effortlessly between each component, querying the system as desired. The use of this type of interface should allow users to utilize more components within the system while improving productivity and reducing training time for new applications or software packages (Raybould, 1990a).

In addition, each component should be context-linked to every other component with easy access between each module, similar in some ways to the integrated modules available in some types of computer software which link information from one module to another. With this type of interface, the system almost "knows" what is being searched for when a request is made (Puterbaugh, 1990c).

With this emphasis on ease of use, the integration of the system components should be based on the least experienced user's knowledge and mental abilities (Gery, 1989a), while still being helpful to even the most experienced user. While this wide range of potential users will cause some difficulty during the design and

development of a performance support system, it will make the package useful for all employees whose tasks are supported by the system.

The integration of these components is also described by Horn (1989), who provides the following guidelines for this process:

- the provision of a common interface between all components to reduce navigation problems and optimize access times,
- direct access by the user to any topic or task regardless of context, and
- support for multiple levels of assistance depending on the experience level of the user and the current problem.

Development and Distribution of Performance Support Systems

Gery (1989a) describes a relational data base structure as the most powerful tool for developing a performance support system, while less powerful forms include software indexing systems (e.g., on-line reference systems), information structuring tools (e.g., HyperCard), hierarchical databases, and software implemented through programming languages. Raybould (1990a) also describes several potential development tools including text management and retrieval systems, computer-based reference systems, electronic documentation systems, hypertext systems, knowledge processors, expert system shells, CBT authoring languages, and user interface environments. The exact choice of a software tool to be used in the development process, however, should be based on the specific needs for the performance support system in a particular environment within an organization.

Raybould (1990b) lists several other design considerations for building a performance support system including:

- which platform technology to use;
- which distribution media to use (magnetic or optical);
- which distribution network to use (centralized or local);
- how to successfully integrate several different technologies and platforms into a single system;
- how to assist users in finding information quickly, easily, and completely; and
- how best to organize the information.

Based on these questions, Raybould (1990a) makes the following recommendations for distributing the finalized, performance support system to potential users:

- If the information life cycle is less than 3 months, distribute the system on magnetic media.
- If the volume of information is less than a few megabytes, use diskettes.
- If the /olume of information is larger than a few megabytes and the life-cycle is relatively short, a network solution may be appropriate.

- If the life-cycle is relatively long and the volume of information is quite large, CD-ROM may be appropriate.
- If the information is relatively static over time, the information can be published on CD-ROM with updates distributed on magnetic disks or posted on electronic bulletin boards.

Future Potential for Performance Support Systems

According to (Gery, 1989a), performance support tools will see widespread adoption in the foreseeable future due to the availability of the technology, the explosion of creativity in methods for using this technology, and the inadequacy of training as it is currently conducted in organizations today. In addition, current methodologies cannot improve employee performance quickly enough to meet the changingbusiness conditions of current and future organizations. While performance support tools do not replace all training requirements within an organization, they can be quite effective at increasing employee productivity during the performance of required, work-related tasks.

However, the use of any technological system within an organization requires a careful analysis of needs, current systems, and projected requirements to be effective. This information, in conjunction with a better understanding of knowledge support systems and their potential for employee assistance, will help to increase the adoption of such systems, where appropriate, and reduce the need for traditional training that may not be appropriate or cost effective.

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AUTHOR

William D. Milheim is Assistant Professor, Instructional Systems Program, Penn State Great Valley, 30 E. Swedesford Road, Malvern, PA 19355.