Performance Support Solutions: What You Need When You Need It

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ABSTRACT

Performance support system (PSS) products are tools that supplement the performance limitations of a performer or system. These products can manifest in many forms ranging from simple paper based quick references to portable data assistant (PDA) applications and fully web deliverable immersive synthetic environments. In many forms, these applications are widely used in government and industry, including the U.S. Coast Guard, Federal Aviation Administration, and U.S. Marine Corps. This presentation includes practical examples of replicable tools and methods proponents can use to foster cost-effective PSS development and implementation within any organization. Drawing on case study examples and practical applications that blend simulation, training and exercises with PSS to significantly improve field performance, various models and perspectives are explored. Specific elements include:

- Presentation of a take-away performance support model participants can use to identify when PSS is appropriate and, if so, what sort of PSS solution will best fit their needs. Model elements include price/cost, solution sets, training Vs. PSS, project complexity/scalability, media, deployment strategies relative to infrastructure and cultural readiness.
- Definition supported by examples to highlight the differences between performance support, training, and simple job aids and examples of methods for moving desktop support to other delivery methods when the performer doesn't work at a desktop or in an office environment.
- Methods and perspectives that can be applied to blend training and performance support into powerful and complementary learning/job support tools, including designing solution complexity based on user/performer expertise and creating performer and job appropriate PSS interfaces, metaphors, and language.
- Demonstration of highly engaging and effective non-vendor specific PSS examples that range from PDA based solutions to server delivered desktop immersive environments.

ABOUT THE AUTHORS

Rich Arnold is an Instructional and Performance Technologist and Vice President of the Training and Simulation Division at UNITECH. During a 24 year Coast Guard career Rich helped design and create the service's Performance Technology Center and led many of the Coast Guard's key e-learning efforts including the national implementation of Synchronous WBT, identified and created cost-effective EPSS and CBT solutions that are still used today. Rich currently assists industry, military and federal government organizations identify and create cost-effective training, simulation and performance support solutions. A past-president of the Federal Government Distance Learning Association, military chapter of the International Society of Performance Improvement and a current adjunct faculty member at Old Dominion University, Rich is very active in the performance support, exercise and e-learning communities.

Steve Flowers is learning systems engineer and developer at the Coast Guard's Performance Technology Center in Yorktown, VA. Steve is currently a key member of the Coast Guard working group that is planning, coordinating and creating components for the Coast Guard's e-learning system. The system currently accounts for many flavors of training events blended with performance support, games, and collaborative tools/events. Steve is leading the center's efforts to use gaming technology to achieve improved learning and performance within innovative and cost-effective applications.

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TECHNOLOGY SHOULD SUPPORT HUMAN PERFORMANCE

Technology is rightly used only when it serves the needs and goals of people, and people are wrongly used when they serve the needs of technology (Robison, 2003). Performance support normally implies the application of technology approaches to supporting human performance and accomplishment. Electronic Performance Support System (EPSS) approaches to supporting human performance with technology has grown into widespread movement since its beginnings in 1989 (Marion, 1997), and has been embraced by the Royal Navy, the United States Coast Guard, the United States Navy, and other military services around the world.

While EPSSs have been successfully implemented in industry, these knowledge support methods are particularly useful to military organizations. The mission make up and typical performer profile of military services represent unique human performance taxonomy, seldom seen in industry. The military services carry responsibility for multiple complicated mission tasks, yet the performers of these tasks are quite typically not formally educated in the field of this performance. Often these tasks are performed infrequently, the consequences of failure are high, and the there is a low expectation of the performer being able to commit the knowledge to memory for accurate recall.

Across the board, job tasks are becoming more complex over time, more knowledge is required to do today's jobs. The trade-off for the increased system complexity is enhanced capability. Workers may be reaching a saturation point with complexity, without any indication of jobs actually becoming simpler. Workers are increasingly inundated with artificial devices to support them in their work, with a view to *empowering* them to accomplish more (Norman, 1993). The average worker today faces a multitude of technologies. Richard Swenson, a family practice physician, observed that most of the patients he treats suffer from stress-related problems. One of the most common complaints is the constant bombardment of information from computerized tools and entertainment media (Swenson, 1995). Workers are overwhelmed, people are overwhelmed with complex and wide ranging categories of information, often pushed directly to them in their daily lives.

There are two logical solutions to the problem of complicated tasks and information overload. One could adopt the anti-technology opinion that the impact of technology has been so negative that we discontinue using it the way we have (Mander, 1991), or, one could acknowledge the tremendous potential benefits of the appropriate application of simplifying technology and harness its use in human-friendly ways.

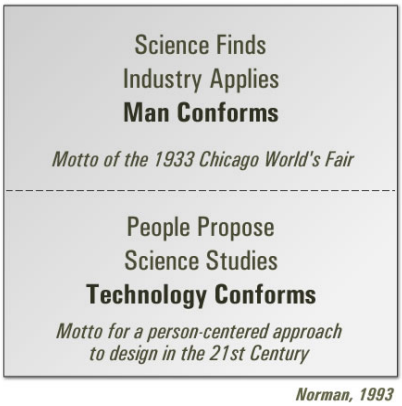

Figure 1. Technology Conforms

What is Technology?

Technology has many definitions, most of which apply in some context to human performance support. The word technology was coined by Harvard professor Jacob Bigelow in the late 1820s from the Greek "techne" referring to an art, craft or skill. Historians, engineers and futurists are only a few of the pundits who have examined technology's past, current and future role in shaping the world we live in given that

technology is as old as the human race and has played a major role in shaping mankind over the millennia.

Technology covers a broad range of systems including modern agriculture, machines, weapons and the myriad constructs that support modern society. At a core level successful technologies require organization and system to permeate through a culture. Organization to pull together the labor and outputs from a broad range of individuals and activities and then system to combine what at first glance may appear to be disparate devices, skills and structures into a coherent structure In short technology is a "system based on the application of knowledge, manifested in physical objects and organizational forms, for the attainment of specific goals" (Volti).

Volti defines and examines technology as a means to achieve goals within the framework of a system. Further examination sets the stage for using technology to achieve specific performance improvement outcomes, especially those related from the application of skills and knowledge within a broader organizational system or retrievable construct. Three key elements comprise this view of technology as a performance enabler. They are:

1. The scientific method of identifying and retrieving material used to achieve a commercial or industrial objective.
2. The discipline dealing with the art or science of applying knowledge to practical problems.
3. Use of electronic or digital products and systems formed into a group to support information on-demand storage and retrieval.

Each of these technological attributes is a key component of a technological definition that is targeted at directly supporting improved performance. Thus, a definition for performance technology examined through the lens of a job/task support model is:

Technology is any tool or vessel that contains or attempts the transfer of information, to or between humans, for any intended duration of retention.

Any tool or vessel. By this definition, paper, decals, tools, calculators, mobile computers, Web resources, telephones, and mass media storage devices (e.g., audio CD's, DVD's, memory sticks) easily fit into the category of technology.

Information, for any duration of retention. Information may be required for two seconds of critical performance, or over an extended period of performance since the specific information needs of individuals varies based on their entering knowledge/skill base, stress/fatigue levels, task saturation point, the performance of others and the performance and reliability of the system. Although developers can and should examine common demographic factors related to content, interface design and performance specifications they also need to accommodate a broad range of individuals who will enter a performance support system for a wide variety of needs. In other words, there is no constant or expectation for capacity or term of information storage. Defining common denominators for human limits is the first part of figuring out an appropriate solution to supplement the physical or cognitive limits of the performer.

For example, a design team needed to create a performance support tool to help operations managers and technicians operate a complex system with components that were critical yet rarely failed. Traditional training would have required frequent refresher to prevent knowledge and skill erosion. Instead the team created an immersive environment based on specific performance observations to ensure the PSS is centered around the performers' needs. The final system includes simulation, task support, mini exercises, and context sensitive help to support the *specific* performance requirements of each individual worker.

The PSS was placed into a virtual immersive environment to provide visual stimulation and organizational structure akin to the typical user's operating station. Part-task mini-simulations that replicate typical performance problems and their corrective measures, specific granular fact/process retrieval support to provide real-time trouble-shooting and corrective measure support and eventually station-to-station collaboration for "off-normal" problem resolution provided via on-demand support. The tool also includes linked practice drills to help spur further cognitive skill development beyond a simple check/implement process. Figure 2 includes a sample interface from the tool.

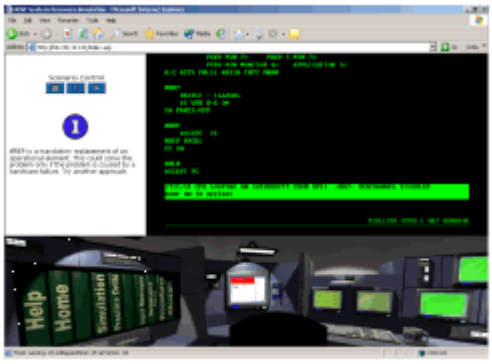

Figure 2. FAA PSS Screen Shot

When you consider that all organizational accomplishment is essentially human accomplishment, support of the people doing the work takes on new meaning. Even in the case of achievement assisted by technology, the technology is conceived by people, built by people, and used by people to accomplish ends that were defined by people. The previous example exemplifies this approach. By providing multiple levels of targeted assistance in an intuitive and recognized framework the PSS provides individual users with the specific support they need from a common tool.

Why Is This Important?

As noted in this section, technology is a means to an end and, except in cases of prestige (because we can!) or research (how does this work?), should be connected to real outcomes that meet individual and organizational needs, objectives and goals. Performance support tools exactly fit that requirement, especially tools deliverable to the user at their point of need…the job site.

PERFORMANCE SUPPORT SYSTEM CRITERIA

Point of Performance Support

Performance support systems need to provide the minimum "information, guidance, advice and assistance, data images, tools and assessment and monitoring systems" needed to accomplish a job with minimal local assistance from others (Gery, 1989).

Good performance support systems must also provide that support at the worker's point of need. A system that cannot be used at the point of performance loses most of its support value. Systems must support workers right at, or as close as possible to, the point of need. That point of need is typically the location and time where they perform the work and must face the consequences of a knowledge/skill gap.

Much of the literature focuses on the point of location but equally important is the concept of point of time. For example, a watch officer in a command center will experience different stressors during periods of minimal operations that those experienced during high tempo time-sensitive periods. Tools truly designed to support "just-in-time" performance will often look different then those designed to support "as it occurs" performance. The watch officer's point of presence (location) is the same, but a tool designed to *prepare* for performance in a non-task saturated time critical environment will typically look different than one designed to support performance in a time critical and context sensitive situation.

Those familiar with Geary's reference will notice the substitution of 'external' with 'local'. Technical capabilities are enabling remote assistance from real humans. These are often the best experts or support personnel with familiarity and access to boundless support resources. Considering the performer's needs, the easiest path to success is often the successful path recommended by those who have already mastered the performance. If a "human free system" is unable to provide this level of experience support to the point of performance, easy remote access to human backed 'ask Bob' services are an excellent alternative.

The growing availability of higher bandwidth wireless services and inexpensive display devices are technology enablers that can support this sort of performance. A busy executive can quickly send a request for information or technical assistance from a palm sized wireless pad or a cell phone…why not a field technician? Include a camera option and a worker in the field can receive complex remote assistance. Tele-medicine, field technician system support, and data sharing are just a few examples. "Just ask Bob" may at first glance appear whimsical but help desks have a long history of supporting performance. Granted many companies seem to design anti-help desks but the basic concept of supporting performance with an on-call resource couldn't fly in many military settings due to the relatively high cost of maintaining the staff and connecting far-flung workers. Technology offers us at least some ability to close that gap, especially for very critical performance functions.

Intuitive design, rich levels of supporting media (show me Vs. tell me) and immediate access are the hallmarks of a good performance support system and serve to

differentiate a modern performance support solution from a simple job aid or checklist.

Intuitive Use

The optimal system is intuitive to use and does not add to the workers 'technology overhead', especially in task-saturated military environments. Optimal systems also present information using language, images and context appropriate and in step with how the typical user/worker performs the task/uses the information. For example a Coast Guard or Navy boiler technician might use the term "light-off" instead of turn on to describe starting a boiler. Intuitive use includes the interface, taxonomy, language and any special needs required by the intended audience.

Match It To Performance Need

Donald Norman describes two essential performance modes for people.

> The Experiential Mode is where we perceive and react to the events around us, this mode is about efficiency and effectiveness. Aircraft pilots generally operate in the experiential mode. We don't want our pilot thinking through the right way to turn an aircraft to avoid collision, we want these decisions and actions to be automatic.
>
> The Reflective Mode is one of comparison and contrast, judgment and evaluation, thought and decision. Most support workers and decision makers operate in this non-time critical reaction mode.

Each of these performance needs apply to specific tasks and accomplishments in very specific critical contexts.

Optimal performance support systems facilitate appropriate modes of performance given the context of the performance. Therefore, optimal performance systems are context-sensitive (Norman, 1993).

Performance systems must also be responsive to organizational needs and goals. Developers need to examine the systems issues, performance gaps and potential problem areas that need to be supported via the PSS. Human performance technology (HPT) provides organizations with a framework to accomplish this analysis.

DIFFERENTIATING TRAINING FROM PERFORMANCE SUPPORT

Training Limitations

Technology offers a wide variety of methods to deliver initial and refresher training, especially training designed to meet cognitive and affected domain objectives. Traditional face-to-face methods are increasingly fused with computer-based training, asynchronous and synchronous web-based training, desktop conferencing, interactive video teletraining, web logs (blogs), distributed exercises, immersive simulations, and games to provide core skill and knowledge competency.

Training is a time-tested and battle proven method to help people perform at an appropriate level. Modern instructional systems design (ISD) is designed to help sponsors create training programs that are cost-effective and efficient. Training, despite its many benefits also has limitations that can be at least partially corrected by fusing training with performance support.

Designing to a Common Denominator

Training courses differ from mentoring or coaching programs in that they are typically designed to support knowledge and skill acquisition for large groups of individuals. Although good course designers can examine student demographics, create common objectives around sound performance outcomes, the mass nature of most courses means that most students will *generally* receive what they need but it is challenging to meet each learner's *specific* needs including different learning styles, vocational abilities, entering skill/knowledge gaps and post-delivery transfer opportunities.

Lack of Resources to Conduct Repetition

Operational tempo, limited manpower and scarce overhead resources make it difficult to build in the repetitions necessary for trainees to develop long-term retention if new skills and knowledge. That is especially true in technology based learning applications that often feature train to comprehension sequences that do not effectively support train to memory long-term retention. How many of us can still pass our college finals or remember skills and tasks used in one discrete military tour or posting? Training is often less effective when viewed six or 12 months after a course, especially if the trainee lacks the support

network, work assignments and coaching needed to prevent training encapsulation and promote effective training transfer.

Performance support tools, if robust enough, offer each individual to find the context specific support they need to accomplish a task. Since each individual does not have to use all of the available information and task support within the system the overall use is more efficient. They get what they need when they need it to achieve maximum system efficiency, especially if the PSS is designed on intuitive and user-centric principles (McGraw, 1994).

Training Lacks Individualized Support

Training is commonly provided to groups to ensure efficient use of resources and thus often is delivered to meet group needs, a somewhat generic approach that may not meet the needs of individuals. Thus training tends to focus on common objectives, especially if the sponsoring organization cannot afford to maintain separate and distinct training threads for each specific field-based setting that graduates will operate in.

Job qualification records, qualification standards and other unit specific training programs typically make up the gap between the generic "one shoe fits all" course and the specific needs of the graduate's home unit or work center. Varying levels of quality, stretched staff with other non-training core duties and, especially with minimal/optimal crew sizes, lack of organic supporting unit experts can make it difficult for a graduate to get the additional training and mentoring needed to translate generic training into specific work outputs.

Performance support can provide the context specific tips and task support needed to bridge the gap between formal training and informal work performance.

Limited Opportunities For Real and Near-Real Time Refresher Support.

The same resource constraints that limit access to initial training can also make it difficult to provide timely and specific refresher training. Again, technology in the form of distributed training offers great relief in this area but most military units face continuous skill and knowledge erosion, especially when personnel are engaged in atypical; tasks (i.e., an artillery unit shifts to a civil affairs mission for an extended period of time).

Lack of reliable cost-effective refresher support means that skill and knowledge erosion, especially for difficult and infrequent tasks, can severely reduce a training program's benefits over time.

Performance support systems will not reduce skill and knowledge erosion but they can ameliorate the effect. Task specific support can enable a worker to quickly return to a level of performance equivalent to expert levels. In one series of studies demographically equivalent workers were randomly placed into two groups, tested and then compared against each other. Both groups performed equally well in their initial training but both also suffered significant knowledge and skill erosion. One group received a performance support system while the other used traditional tools and references. The group using the performance support system performed significantly better in both time on task (faster performance) and quality of task (task performed to standard) (Arnold, 2001).

Blurring the Difference Between Training and PSS

Performance support systems provide users with the specific knowledge and skills support they need to accomplish tasks to enable expert performance without actually having to become an expert (Geary). Training may also be moving in this same direction. Trends include reducing large courses into smaller task specific and embedded training applications, as exemplified by the U.S. Army's Future Combat System (FCS). FCS approaches near-real time mission simulation and task support by providing embedded training and near-real time mission rehearsal (TRADOC, 2002).

SCORM and the rise of reusable learning objects (RLOs) sets the stage for a shift to small granular training applications that begin to look like performance support systems. This sort of granular approach is very similar to providing task specific performance support in that the learner can control or access just what they need when they need it, even if the training is placed into a larger course framework.

Instructional systems designers and performance support advocates can reap maximum benefits from linking training and PSS into one seamless structure. For example, designers created a more powerful sensitive security information course by creating an asynchronous CBT with direct links into an associated PSS. The tool linked to the training and the course linked to the tool. Users could move easily between the two constructs to either get specific task support or learn foundational material. Developing similar

products from subjects ranging from instructional systems design "how to" courses to technical systems administration programs yields a highly beneficial system for both sponsors and users. In effect, training becomes more like performance support and performance support easily bridges into training.

CHALLENGES TO CONSIDER

Designers must overcome technical, organizational, distribution and system challenges to create effective PSS. Failing to plan for them can derail an otherwise successful project. Using PSS to improve performance, especially in organizations dedicated to "solving" performance issues via training, can be problematic when policies and organizational practices do not support using a non-training improvement intervention.

Designers and sponsor need to examine the technical challenges related to system selection, human and form factor analysis, cost-benefit of the PSS versus the cost of the associated performance problem and other organizational issues require review to ensure that a fielded PSS actually results in improved performance.

CREATING A SUCCESSFUL PSS

Although complexity, look, feel and delivery may vary widely between applications there are several common factors to consider when creating and deploying a PSS.

Cost-Benefit Analysis (CBA)

PSS can render cost-effective performance support, especially when compared against instructor-led training programs. Still, the solution should be less expensive than the performance problem it's designed to solve. CBA can indicate if a PSS is an appropriate solution and if so what type of PSS is needed. For example, a simple help-driven PSS may be more cost-effective than a simulation based PSS. CBA should examine costs for design and development, distribution, and life-cycle maintenance support. Is PSS based on a complex database with high-end media or will is it a simple help-based text system? Is the content stable and will it be difficult to maintain currency if it frequently changes? Can sponsors afford to create sufficient redundancy within the system to ensure that users who rely on the PSS still have access to supporting assistance if a display device fails or access is limited due to delivery constraints? These types of questions can have a major impact on PSS cost-benefit.

Life-cycle support includes technology replacement, content updates and policy updates. Refresh rates can be significant depending on the technology selected to deploy and access the PSS and will usually include both hardware and software upgrades. Life-cycle maintenance should also include completing content revisions tied to policy and best practice changes.

Form and Human Factors

Form factor selection and human factors consideration are critical to a successful PSS implementation. **Form factors** apply to the solution deployment hardware and include environment constraints and perceived user convenience, comfort, and portability.

Table 1. Form Factors

Dimensions
The width, height and depth specification of a deployed technology platform (and all required peripherals) have implications on the storage and portability of a solution. If a user needs to squeeze into a small man-sized space, a tablet PC might not be a good choice.
Weight & Balance
Technology has done great things for the weight of tools. However, it is still a consideration. If a solution is too heavy, or is unbalanced and tips over, falls off, or is thrown across the room – workers will stop using it.
Ergonomics (Handle / Mount)
If a performance support system requires the sacrifice of appendages or tools, users will lose appreciation for the tool. Don't make me give up my hands! This may be a key reason why there are only a few examples of successful PDA based PSS. This can also apply to paper based implementations. In what situation would a user want to unfold a 4' by 4' map onboard a moving vessel? Is the user going to be worried about dropping the tool?
Display Specifications
The size and resolution of a display affect the amount of information that can be presented and the representation of tasks and reference images.
Input
One reason many workers don't like PDA's is because they haven't caught on to the standard input device (touch screen SIP or recognition). How does the user interact with the application (touch screen, voice activation, keypad, dictation)?
Peripheral Requirements
Are external peripherals required to operate the solution (cables, input / output, storage)?
Data Interface
How is data captured, stored with persistence and synchronization and pooled when occasionally connected? How are pick lists populated?

Environment Resistance
Water, temperature, worker abuse. Oily water in the bilge? How hot is the space where the worker will be using the solution? How rough and tumble is the job?

Human factors affect people in their work environment. Human factors that can be addressed by a PSS include motivation, ease of use and accessibility concerns and any capabilities, limitations and senses that are human specific. The user experience within the tool is also critical. Is it too easy to make mistakes in the system? Is the system too hard to use?

If you pit a good performer against a bad system, the system will win almost every time.
-Gerry Rummler & Alan Brache

Table 2. Human Factors

Motivation
The reasons a user would want to use the tool. Are there significant benefits over standard support and reference tools? Does the tool look professional and reflect apparent excellence qualities?
Usability, Ease of use & Accessibility
How easy is the tool to use? Are there unnecessary tiers of navigation? Can I search for information? If I have trouble seeing, does the display and presentation design address my needs?

Organization and Performance factors scale beyond specific human factors and include policy support, culture, and specific needs of the performer. Other factors that affect the efficacy of the solution, and increase the chances the tool will be used as intended, include availability, reliability and risk mitigation.

Table 3. Other Factors

Availability
Access to tools is a critical issue. If a maintenance worker needs to climb three sets of stairs to access the tool to support equipment three floors below, the tool hasn't been deployed correctly.
Reliability
I won't use it if it fails all of the time, even if it is a great tool. Frustration from unreliable tools is a leading cause of disuse.
Risk Mitigation
Will the tool help to keep me from making mistakes? In the cases of high risk operations, that don't have a time sensitive component, risk mitigation is a great motivator for cultural acceptance of an intervention.

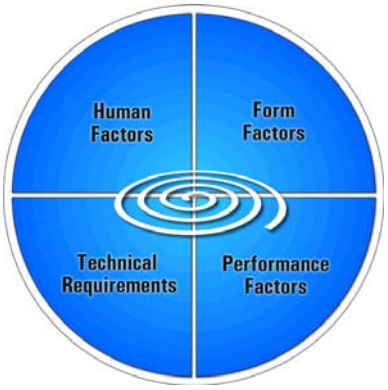

Figure 3. Requirements and Factors Spiral

PSS Design

PSS design should follow a structured approach similar to the process typically used by instructional systems designers to develop objectives associated with training programs. However, before jumping to specific design analysts should determine if using a PSS will actually result in the desired performance improvement.

PSS is often a preferred solution when performance gaps result from a user's inability to adequately perform infrequent tasks or tasks that are complex in nature with multiple steps, are non-intuitive, or require additional media (e.g., a series of high quality graphics, video clips, or animation) beyond simple print based line drawings or static graphics.

Planners need to examine audience profiles, determine root cause and build associated material, mini-training programs and other PSS elements into an intuitive construct that users can easily navigate and through to quickly find the help, assistance and task-specific support they need to perform their jobs.

Design features must also account for the limits of the intended display devices, bandwidth considerations and other technical limits, including overall complexity. The authors' have observed otherwise successful projects suffer when design teams inserted too much extraneous low-value content and non-performance related material into a lean and functional product. Too much bulk can lose key call-outs and context-sensitive elements in a haze of irrelevant information that made it difficult for users to focus on more germane content.

Additionally, designers should resist developing a more complex solution when a simple one will fit. A

"perfect" PSS may cost more than the actual performance problem it's designed to solve. A simple solution that solves the bulk of the performance issues in the field is often a more cost-effective and overall functional program than a more costly long development lead-time PSS. IN short, designers need to determine in advance of production the level of fidelity required for the PSS.

PSS Solution Elements

PSS, like training and simulation programs can vary widely in scope, size and complexity. As noted in the previous section, designers need to carefully align PSS elements with the desired performance. For example, a PSS designed to help technicians troubleshoot a mechanical system may use major fault descriptions as its entering navigation elements while a PSS focused on policy support may relay on linked structure built around book metaphor. Organizations fielding multiple PSS may want to standardize navigational interfaces, media players and other elements.

More complex PSS may call out or use other software elements (e.g., document viewers, CBT programs, simulations, media players, note-taking/text recording programs) as either components or related links.

Media Constraints and Requirements

Media requirements can be critical design decisions. Media is a powerful but costly tool, and like many other components of the PSS system, have costs that live beyond development. The first criteria that should be considered is the organization's capability to support a class of media selection. One example of a commonly considered system constraint is bandwidth and connectivity. Without connectivity and sufficient bandwidth, heavy media and data transmission become difficult, burdensome or impossible. Media requirements are also driven by the form factor selection and human factors emphasized in the outcome of the task and user analysis. The correct selection of media can improve articulation of principles, concepts, processes, procedures, and facts. The incorrect selection of media can detract from or destroy these elements.

Media can also have a significant impact on usability, and situations where an organization wants to affect choices workers make when value judgments are required. Many media selection tools exist and most apply ratings from user, cost, and infrastructure analysis to a selection score. Most models address deployment classification and framework and stop short of granular media strategy identification, it may be better to separate into correlated Technology Selection and Media Selection models. Table 4 lists media selection criteria. Developers need to consider these factors when selecting PSS media elements.

Table 4. Media

User Criteria
• Access (Form factor, Availability, Bandwidth and Connectivity) • Receptivity • Frequency of Performance • Expertise Level • Prior Experience / Knowledge
Cost Criteria
• Delta (Change) Frequency • Audience Numbers • Time to train • Budget! • Return On Investment (ROI) and CBA • Implementation Costs • Maintenance Costs • Delivery Costs • Evaluation Requirements
Infrastructure Criteria
• Bandwidth and Connectivity • Form Factor Requirements • Hardware and Software considerations • Media Type / Classification Selections

Figure 4 is a screen capture of an online guide, an example of an avatar designed to provide context sensitive coaching, tips, and information for an Incident Command System application. This example exemplifies using more robust media to create a more "personal" experience than a simple text-based PSS.

Figure 4. Avatar Guide/Coach

Deployment Strategies Relative to Infrastructure

A passive solution can be defined as a tool that recalls and displays information, while an active solution

requires some client or server processing to exchange data, run calculations, or adapt to a user type. Deploying a robust solution of either type can be a challenge. In most cases, performers do their work 'off the network' and use portable tools to support their work. The U.S. Coast Guard adopted a Web native deployment philosophy for passive solutions to ensure applications will run via a network, CD-ROM or portable storage device. There are a few options available for active solutions. The Instructional Support Team at USCG Training Center Petaluma, CA developed a PDA based PSS called mTech for technicians and maintainers. The PSS runs within the Flash Standalone Player and calls data from an XML file. The USCG Performance Technology Center in Yorktown, VA experimented with persistent data interchange and synchronization using a variety of methods including visual basic and client side ASP processing. For connected devices, standard server side solutions remove many of the challenges associated with an occasionally connected active solution.

Cultural and Organizational Readiness

Finally, even the best PSS may fail if it is not deployed within the framework of supporting policy and process. Can technicians use the PSS to conduct troubleshooting or is there an agency requirement to use a paper-based manuals? The benefits of a well-designed PSS may be compelling, but the project may fail if the organization does not or cannot accept the PSS as a reliable tool.

Cultural and organizational readiness also includes determining if the sponsor has the system needed to support the underlying technology associated with the PSS. Will sponsors be able to provide sufficient access devices (i.e., PDA, tablet or computer)? If tools are embedded in actual equipment will accessing the PSS detract from using operational systems? Planners and sponsors need to carefully examine the governing directives, standard operating procedures (including tacit unwritten common practice) and technological constraints associated with the PSS.

PORTABLE AND WIRELESS-BASED PSS

The term electronic performance support system has shifted to the more generic performance support system since the electronic feature of EPSS has become a given assumption. PSS deployment systems are following a similar trajectory as the personal computer. Initially EPSS were often used to help workers use software tools and other computer processing functions.

Just as computers continue to follow a path towards increased power at reduced size, so to are PSS. Recent improvements in PDA sized device screen displays, ergonomic controls, memory storage and robust wireless connectivity make portable PSS a reality. Portable "any where/any time" connected devices enable developers to create PSS that truly provide point of presence job support without adding burdensome infrastructure. The epitome of this trend is arguably the planned Army FCS (TRADOC).

As portable phones, e-mail devices, and other tools merge with PDAs the potential to link asynchronous and synchronous PSS elements with part-task training become very cost-effective and relatively easy to execute. For example, we created a job aid decision tool for Department of Energy officials that operates on a standard COTS PDA. The PSS helps the officials to quickly complete key documents while in the field. Not very complex and it requires very little media, but key facts, data collection and practical tips are included in the system, right at the user's fingertips.

Another example is a Coast Guard experiment that customized COTS software to exchange search and position data between Search and Rescue coordinators and field units. Both examples typify current trends associated with portable connected tools. Small screen size and limited memory may impair development of robust portable applications but PDA size devices with other tools (i.e., hands-free flexible displays) can improve functionality. Near-term trends indicate that more functional, media-rich PSS that can deliver the performance support you need when and where you need it will become an increasingly affordable and available performance solution.

CONCLUSION

Technology continues to offer huge advantages to the military. However, helping the soldiers, sailors and airman who use that technology to get the most from their systems and equipment requires a shift in emphasis from train to memory solutions to one that incorporates modern performance improvement solutions.

That shift requires changes to more than our typical training programs and methodologies. It also requires changes to the organizational underpinnings that are used to develop, provide and validate training.

Incorporating PSS into training programs will be ineffective unless PSS is also woven into the tapestry of supporting documents (i.e., tech and operating manuals), maintenance methods (i.e., remote tech support via portable/wireless devices) and organizational culture.

Like all technologies, PSS is not a panacea for all training and performance problems. It will provide, within limits as production and delivery systems continue to mature, a superb solution to help people remain as current, functional and efficient as the machines and systems they seek to manage, control and use. Not using PSS to full advantage may result in systems that begin to approach much of the software that we all use in our daily lives. We know it those programs have lots of functionality and features that we should be able to use but often don't have the time or means to figure out. That's inconvenient with a desktop word processing or data management tool but a potentially critical flaw for a critical operational system, machinery set, weapons or sensor system.

REFERENCES

Arnold, R & Brandt, J (2001). "Mentoring the development of low cost web-deliverable electronic performance support systems." *I/ITSEC 2001*

Gery, G. "Training Versus Performance Support: Inadequate Training is Now Insufficient." *Performance Improvement Quarterly*, 1989, vol. 2, no. 3, pp. 51-71.

Gery, G. (1991). *Electronic Performance Support Systems, How and why to remake the workplace through the strategic application of technology*, Tolland, MA: Geary Performance Press

Mander, J. *In the absence of the sacred: the failure of technology and the survival of the Indian nations.* San Francisco: Sierra Club Books, 1991.

Marion, C. "What is Performance-Centered Design?" http://www.chesco.com/~cmarion/PCD/WhatisPCD.html

McGraw, K. (1994, October). *Developing a user-centric EPSS. Technical Skills and Training*, pp. 25-32.

Norman, D.A. *Things That Make Us Smart*. Cambridge, MA: Perseus Books, 1993.

Robison, D. (2003) *Human Centered Performance Support Design. ITEC 2003.*

Swenson, R.A. *Margin*. Colorado Springs, CO: Navpress, 1995.

U.S. Army Training and Doctrine Command, (2002). *White Paper Future Combat System Embedded Training*. Retrieved 20 June 2004, from http://www-tradoc.army.mil/dcssa/Transform/2002-05-08_FCS_Embedded%20Training_White_Paper_v4.doc

Volti, R. (1995). *Society and Technological Change*, New York: St. Martin's Press, Inc.