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Human Performance Technology: A Discipline to Improve C2 Concept Development and Analysis

Track 6: Metrics and Measurement

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Abstract

Human Performance Technology (HPT) is not a device but a rich discipline committed to improving performance using a systematic and holistic approach. A basic description is humans, working within a system to get desired results. The relevance to C2 is unmistakable – information age C2 is increasingly focused on all aspects of the human in the loop. The processes used, while powerful and rigorous, are easy to comprehend. Understanding the important difference between the means and ends, HPT is characterized by efficiently addressing a performance gap with a thorough cause analysis in order to address causes and not just symptoms. During this presentation, the audience will be introduced to HPT history, the ten Standards of Performance Technology, several models associated with HPT, and areas where HPT methodologies can enable optimization of C2. Military staff officers and other professional analysts can develop their HPT analytical skills through research, leading university graduate programs, and a professional organization, the International Society for Performance Improvement. While these programs are focused on dynamic business and social processes, the principles readily transfer to the C2 arena and powerfully compliment the current tools available to C2 concept developers and analysts.

Human Performance Technology: A Discipline to Improve C2 Concept Development and Analysis

"*The human dimension largely distinguishes command and control (C2). Key differences between C2 analyses and traditional military operational analysis (OA) applications include the need not only to deal with military organizations, but also with distributed military teams (and organizations) under stress and their decision making behavior as well. Moreover, in operations other than war (OOTW), consideration must be paid to the behavior of and interaction with non-military organizations, political groupings, and amorphous groups such as crowds and refugees. Thus, the formulation of the problem and the development of solutions strategies cannot be completed without explicit consideration of both human and organizational issue"* (NATO Code of Best Practice for C^2 Assessment, 2002, p. 128).

Introduction

Human Performance Technology (HPT) "is the systematic and systemic identification and removal of barriers to individual and organizational performance" (Chevalier, 2004, p. 1). While being a valuable remedial tool to fix or optimize established processes, its application can also enable a solid design framework invaluable in constructing systems. This aspect is particularly important to military processes that by nature are not recurring production operations. Fred Nickols (personal communication, February 6, 2007) offers "HPT is a body of knowledge, methods, and techniques that have proven useful and effective in arranging the conditions of performance so as to reliably, consistently ensure the achievement of targeted results."

HPT is a maturing discipline; specifically termed in the mid-1970s (Stolovitch, 2000) which has been built on solid foundations of human performance research that can be traced back to the early 1900's. It is useful to put the fact that HPT is a maturing discipline into context of another discipline; management, a term that has been around "forever" to anyone who reads this paper. The "phenomenon of management" as a *discipline*, responsible for the transformation of the "social and economic fabric of the world's developed countries", was unknown prior to the 1850s (Drucker, 2001, p. 4). While fundamental principles of warfare and examples of brilliant battlefield strategists and leadership go back centuries, our current understandings of systematically positively effecting human performance as a discipline are almost entirely based on the research and findings developed in the last century.

It should be clear that HPT and Command and Control (C2) analysis have a commonality that would be useful to further explore. To further refine this thought, a basic description of HPT is: Humans, working within a system, to get desired results – a concept that a C2 analyst can relate to very strongly. HPT is well suited to act as an enabler of optimized C2. This paper will describe the principles of HPT and then make the case of the benefits for the further assimilation of HPT methodologies within the field of C2 analysis. The paper will describe a recently initiated NATO research effort (HFM 156) to further develop the ability to measure C2 effectiveness utilizing a HPT framework.

The processes used in HPT, while powerful and rigorous, are easy to comprehend. Understanding the critical difference between the means and ends, HPT is characterized and hallmarked by scrutinizing a performance gap with a thorough cause analysis in order to address causes, and not just symptoms, to reach the desired results. You do not need to learn a new vocabulary or limit yourself to specific resources, methodologies, or technologies. As described in the Handbook of Human Performance Technology (1st edition), "HPT is open to all means, methods, and media" while "…constantly searching for the most effective and efficient ways to obtain results at the least cost" (Stolovitch and Keeps, 1992, p.7).

The relevance of HPT to C2 analysis is unmistakable – information age C2 analysis is increasingly refocusing on all aspects of the human in the loop (system). There are valuable principles and a plethora of HPT resources that are available now which can significantly contribute to the work of the C2 analyst. Fully recognizing HPT as a valuable field of study for its mid-career officers and civilian C2 analysts is an option that all officials responsible for the development of current and future military and civilian analysts should strongly consider.

More on HPT and C2

To properly set the frame of references, it is useful to present some additional definitions of HPT, and also for C2. Please note that while the "T" in HPT stands for technology, nowhere in these definitions will you see the words "bytes", "bandwidth", or any electronic "tool" references. Technology in HPT refers to the origin of the word "technology" itself, "…the scientific study of practical matters" (Stolovitch and Keeps, 1992, p. 4). "It is a technology that has application to results-driven, productivity-orientated systems…" and "… makes HPT particularly valuable for businesses and industry, where organizational purposes and goals are generally clearly understood" (Stolovitch and Keeps, 1992, p. 5). Gilbert (1992) described it as a science that:

- Has a clear subject matter,
- Simplifies,
- Depends on observation, not hearsay,
- Guided by measurement, and is
- Grounded in measurement

The International Society for Performance Improvement (ISPI, www.ispi.org) breaks down the three words of HPT as follows (2007):

> **Human:** the individuals and groups that make up organizations
> **Performance:** activities and measurable outcomes
> **Technology:** a systematic and systemic approach to solve practical problems

A more comprehensive definition is provided by Benefit and Tate (cited in Stolovitch and Keeps, 1992, p. 6):

> [Human] Performance Technology is the systematic process of identifying opportunities for performance improvement, setting performance standards, identifying performance improvement strategies, performing cost/benefit analysis, selecting performance improvement strategies, ensuring integration with current systems, evaluating the effectiveness of performance improvement strategies, [and] monitoring performance improvement strategies.

One more definition; "Performance technology (PT) is the technology that compromises all of the variables that affect human performance" (Addison and Haig, 2006).

At this point, you may be thinking, "I believe in and use a systematic and systemic approach to solve problems and I don't call it HPT, so what's the big deal?" You may very well be using HPT if you use a systematic and systemic approach to solving problems – however; you will likely greatly benefit in your future endeavors by learning from the insight and research of the community of practice that specifically uses and develops HPT as a discipline, while adding your own contributions to the community.

Definitions of Command and Control

The U.S. Department of Defense defines Command and Control (C2) as:

> The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. (http://www.dtic.mil/doctrine/jel/doddict/data/c/01093.html, 2007)

NATO defines Command and Control as "The Organization, Process, Procedures and Systems necessary to allow timely political and military decision making and to enable military commanders to direct and control military forces (cited in NATO Code of Best Practice for C2 Assessment, 2002).

The functions of C2 have been described as:

> Command and Control is not an end in itself, but it is a means toward creating value (e.g., the accomplishment of a mission). Specifically, Command and Control is about focusing the efforts of a number of entities (individuals and organizations), and resources, including information, toward the achievement of some task, objective, or goal. (Alberts and Hayes, 2006, p. 32).

C2 has been evolving and transforming from an industrial age C2 to an information age C2 (Alberts, 2002,). At this point and time, evolving techniques in HPT and C2 analysis have much in common and each can learn from the other.

Roots and Evolution of HPT

A section in this paper cannot give full justice to annotating and describing the evolution of HPT. A basic framework will therefore be provided for context, and readers are recommended to review the references that more fully document the evolution and maturity of HPT. Thomas Gilbert, considered the father of performance improvement, published his seminal book *Human Competence: Engineering Worthy Performance* in 1978, a result of 20 years of work in performance engineering (Sanders and Ruggles, 2000). Gilbert's contributions, as those of his colleagues and those that followed, were built on, refined from, or used as a point of departure from, earlier works in Scientific Management, Behaviorism, Systems Theory (or system and sub-systems theory), Learning Psychology, Instructional Systems Design, Analytical Systems, Cognitive Engineering, Information Technology, Ergonomics and Human Factors, Psychometrics (measurement of human achievement and capabilities), and Feedback Systems, among others (Chyung, 2005; Rosenberg, Coscarrelli, and Hutchison, 1999; Sanders and Ruggles, 2000). HPT is not only focused on individual performance, but indeed on the performance of the organization, and how that organization interacts with the overall environment. Some examples of this holistic approach are as follows:

- Kaufman's (2006) Mega, Macro, Micro Strategic Planning which calls for consideration of societal (Mega), organizational (Macro), and individual (Micro) levels to be considered in strategic planning.
- Rummler and Brache's (1990) three levels of organizational performance which addresses the relationships between the organization, the processes, and the individual performers.
- Amarant and Tosti's (2006) Whole Organizational Performance Systems Framework that looks at processes from three levels; organizational, operational, and people.

The Principles of Human Performance Technology

The Standards of Performance Technology listed here were developed by the International Society for Performance Improvement (ISPI). They can be found on the ISPI web site (2007) (www.ispi.org) and in the Forward of *Human Performance Technology Revisited* (Chevalier, 2004). Listed below are the specific standards and a further expanded discussion on them can be found in Appendix A:

> Human Performance Technology (HPT) has been described as the systematic and systemic identification and removal of barriers to individual and organizational performance. As such, HPT is governed by a set of underlying principles that serve to differentiate it from other disciplines and to guide practitioners in its use.

1. HPT focuses on outcomes**.**
2. HPT takes a systems view.
3. HPT adds value.
4. HPT establishes partnerships.
5. Be systematic in the assessment of the need or opportunity**.**
6. Be systematic in the analysis of the work and workplace to identify the cause or factors that limit performance.
7. Be systematic in the design of the solution or specification of the requirements of the solution.
8. Be systematic in the development of all or some of the solution and its elements.
9. Be systematic in the implementation of the solution.
10. Be systematic in the evaluation of the process and the results.

HPT Models and other Tools

HPT literature is rich with many different models and tools, many to be found in the *Handbook of Human Performance Technology* (1st ed, 1992) (2nd ed, 1999) (3rd ed, 2006) (Note: Each edition of the Handbook is largely unique and more like a new volume than the same body of work that has been updated). While this paper cannot give justice to all the powerful tools that are available, it can describe some of the base tools available to performance technologists. Figure 1 is the Human Performance Technology Model (Van Tiem, Moseley, & Dessinger, 2004), which also can be found on the ISPI web site (www.ispi.org)

Human Performance Technology Model

1. Used as a performance improvement tool.
2. Used to determine an organization's performance requirements.
3. Used when there are indications of a performance problem.
4. Used when there are indications of internal and external factors affecting performance.

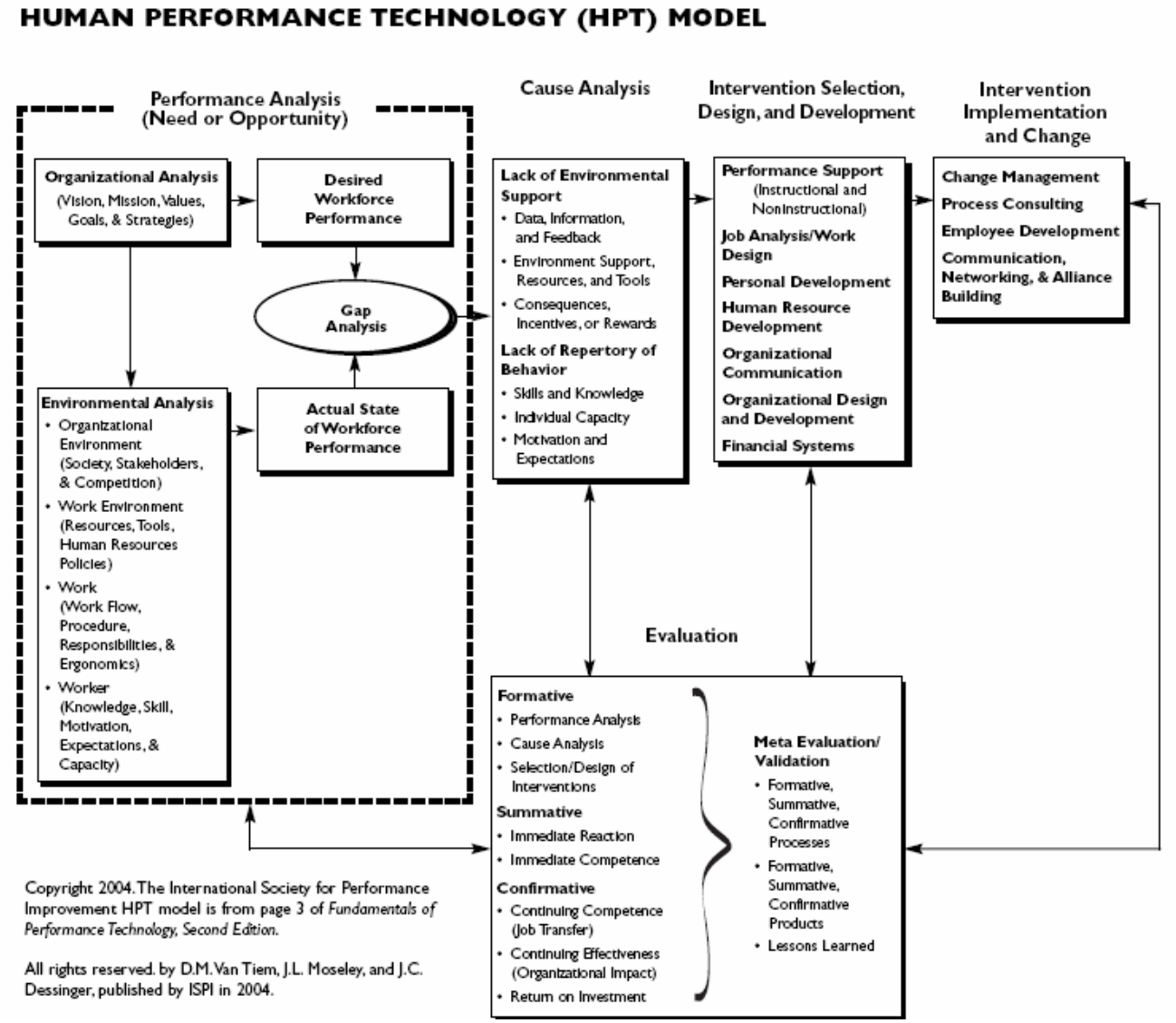


Figure 1. Human Performance Technology Model

Guidelines for using the HPT model:

- Use the HPT model in a sequential systematic manner while seeking to identify systemic problems. Focus on results.
- Be prepared to identify performance improvement opportunities separate from any perceived problems.
- Do a Performance Analysis and identify the Performance Gap.
- Adopt a holistic viewpoint in conducting the Cause Analysis. Look beyond the obvious to identify all significant impacting factors.
- Identify and select (multiple) intervention(s). Usually there is more than one useful intervention that as a package will optimize performance. ROI needs to be considered when selecting interventions.

- Be prepared to act as a change agent to facilitate organizational support during implementation.
- Evaluate the results of the intervention implementation.

Similar to the HPT model is the Human Performance Improvement (HPI) model (Figure 2) that was developed by the American Society of Training and Development (ASTD):

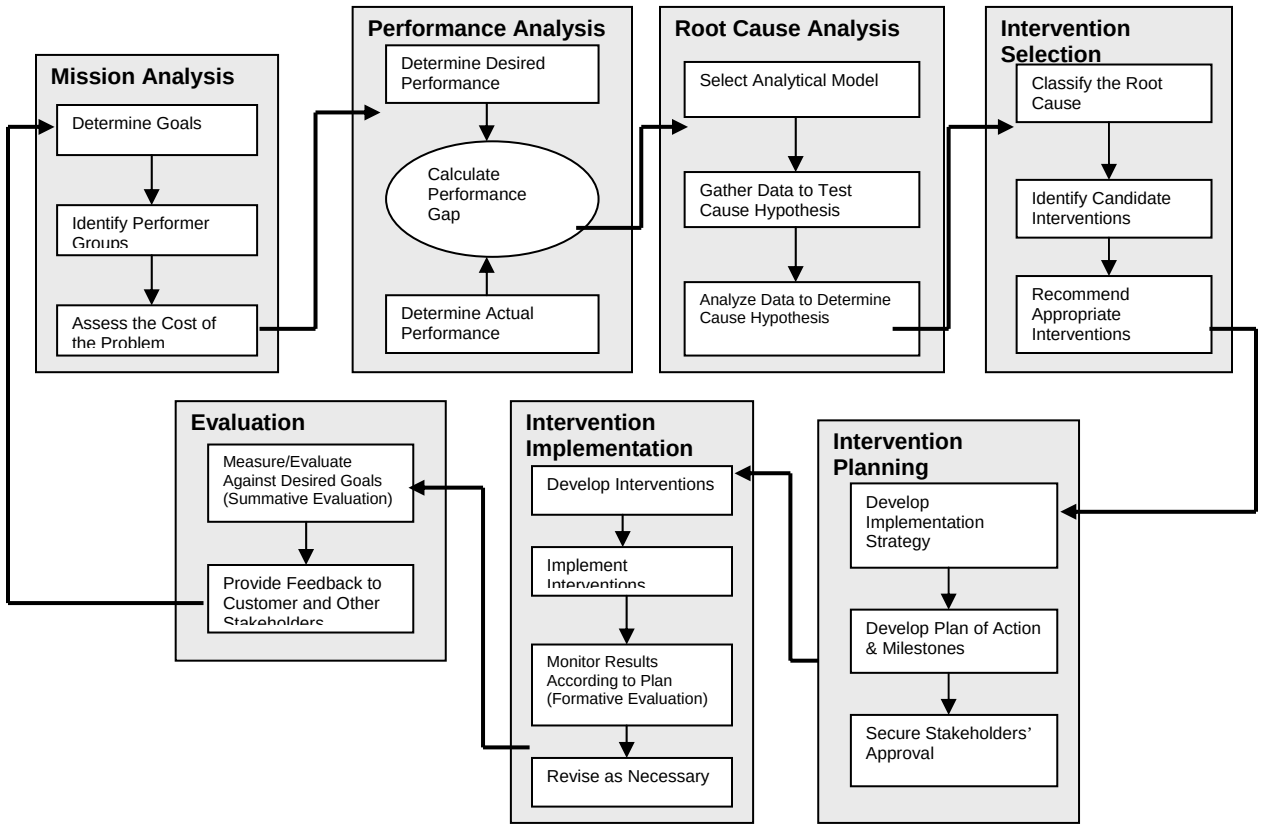


Figure 2. Human Performance Improvement Model

Harless' Front-End Analysis (FEA)

Harless first used the term "Front-end analysis" in 1969 to "describe the rigorous diagnostic framework that needs to be done before addressing a solution to a problem" (Sanders and Ruggles, 2000). Some characteristics of Harless' FEA are:

1. FEA is a performance improvement tool that concentrates on the performance analysis and cause analysis.
2. FEA is a tool used to find the most efficient way to correct a performance problem.
3. Used to identify performance problems that will have a significant positive impact when corrected.
4. Used to isolate the root cause of the performance problem rather than the symptoms or effects of the problem.
5. FEA includes the assumption that training is not always the answer.
6. Used to optimize performance while avoiding other more costly strategies that would not work as well.

FEA consists of 13 "smart questions" used early on as a focused analysis in identifying the cause of a performance problem before addressing a solution. Figure 3 was adapted from a table created by Chyung (2003) which lists the 13 questions grouped by their intended focus.

FEA	**Focus**
1. Do we have a problem? 2. Do we have a performance problem? 3. How will we know when the problem is solved? 4. What is the performance problem? 5. Should we allocate resources to solve it?	▪ Focus on ends (micro, macro or mega level), not means ▪ Formulate desired - actual = gap ▪ Determine the significance of the issue - i.e., which one is more expensive - the cost for not dealing with the problem or the cost for solving the problem?
6. What are the possible causes of the problem? 7. What evidence bears on each possibility? 8. What is the probable cause?	▪ Find the cause and the root causes - e.g., use a cause-effect diagram
9. What general solution type is indicated? 10. What are the alternate subclasses of solution? 11. What are the costs, effects, and development times of each solution? 12. What are the constraints? 13. What are the overall goals?	▪ Be open to more than just training ▪ Think about cost-effectiveness ▪ Think about feasibility ▪ Make sure that the solutions are selected to close/reduce the performance gap

Figure 3. Harless' "13 Smart Questions" Grouped by Focus Areas.

Gilbert's Behavior Engineering Model

Thomas Gilbert is widely considered a pioneer in the field of HPT and many HPT models and tools trace their roots back to his works. In his 1978 book *Human Competence: Engineering Worthy Performance* (1978) one will find his Behavior Engineering Model (BEM). Within the BEM, Gilbert strongly articulates that the greatest leverage for performance improvement can be found in the environmental supports for which management is wholly responsible. Following the environment supports are the individual's repertory of behavior, for which management is also responsible (in that management is responsible for hiring the person, training the person, and removing the person if necessary). In reviewing the BEM (Figure 4), one will see where feedback and guidance is the number one leverage point for performance improvement. If

feedback and guidance are not optimized, interventions in other areas will not likely result in performance improvements. Many costly training programs have failed to improve performance because of this fact. Characteristics of the BEM are:

1. It is used as a Performance Improvement tool.
2. It is used to identify the causes of competence and incompetence.
3. It is used to determine in what areas that management is performing unsatisfactorily.

Environmental Supports (E) and a Person's Repertory of Behavior (P) are the key factors in generating Worthy Performance (W). The following table can be used to track strategies that lead to competence:

	Information	**Instrumentation**	**Motivation**
E: Environment Supports	1. Data Relevant and frequent feedback about the adequacy of performance. Description of what is expected of performance Clear and relevant guides to adequate performance	2. Resources Tools and materials of work designed scientifically to match human factors.	3. Incentives Adequate financial incentives made contingent on performance. Non-monetary incentives. Career development opportunities.
P: Person's Repertory of Behavior	4. Knowledge Scientifically designed training that matches the requirements of exemplary performance. Placement	5. Capacity • Flexible scheduling of performance to match peak capacity. • Prosthesis • Physical shaping • Adaptation • Selection	6. Motives Assessment of people's motives to work. Recruitment of people to match the realities of the situation

Figure 4. Gilbert's Behavior Engineering Model

Guidelines for using the BEM:

- Identify a performance improvement opportunity.
- Be aware that management is responsible for poor performance.
- Systematically examine the situation using the six areas of the BEM table.
- Maintain the sequence (particularly analyzing environment supports prior to the individual's repertory of behavior) of the components in searching for causes of performance barriers. If an area is found to contain a barrier to desired performance, determine if there is a cost effective intervention to solve the performance barrier. Be aware that a correction in one area will often have a cascading effect on another area, often for the better.

- Be aware that performance problems are often fixed by adjusting the Environmental Support components, and it is not often necessary and/or cost effective to adjust the "Capacity" and "Motives" components.
- Roger Chevalier (2003, 2006) has an updated BEM that recommends that the knowledge component be the last component analyzed in the sequence as the performance problem can often be solved more efficiently by addressing problems found in the other component areas. His article can be retrieved at http://www.pignc-ispi.com/articles/Vol42_05_08.pdf and addresses leverage points and force fields involved in performance solutions.

GAP-ACT Model

The GAP-ACT Model is simple yet does have significant implications for information age C2, as Power to the Edge requires empowered individuals and leaders in a distributed environment. The value of the model is that it "…is a simple, easily used tool for examining, understanding, improving human performance" based on the Perceptual Control Theory developed by William T. Powers (Nickols, 2007). Letters in the model represent:

G - represents Goal.
P - represents Perception
A - represents Action
C - represents other Conditions
T - represents Targeted Variables we seek to affect or control
d - represents action in response to resolve the discrepancies between G and P
i - represents interventions with an outcome or result in mind

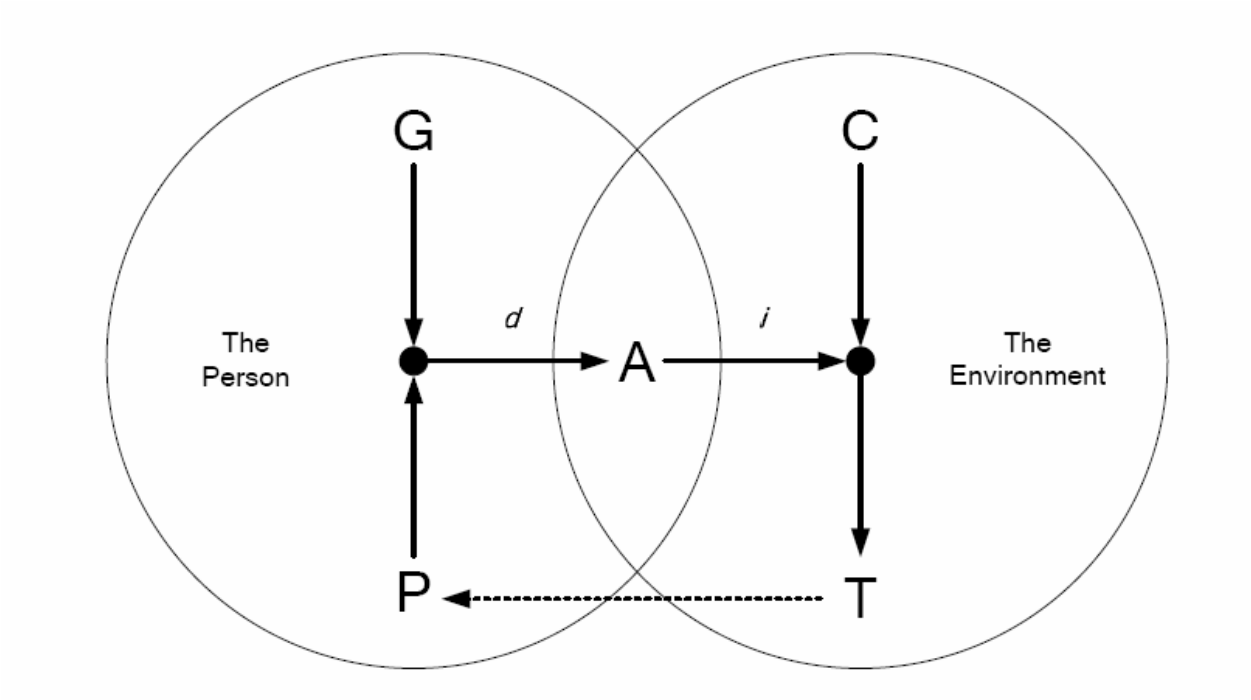
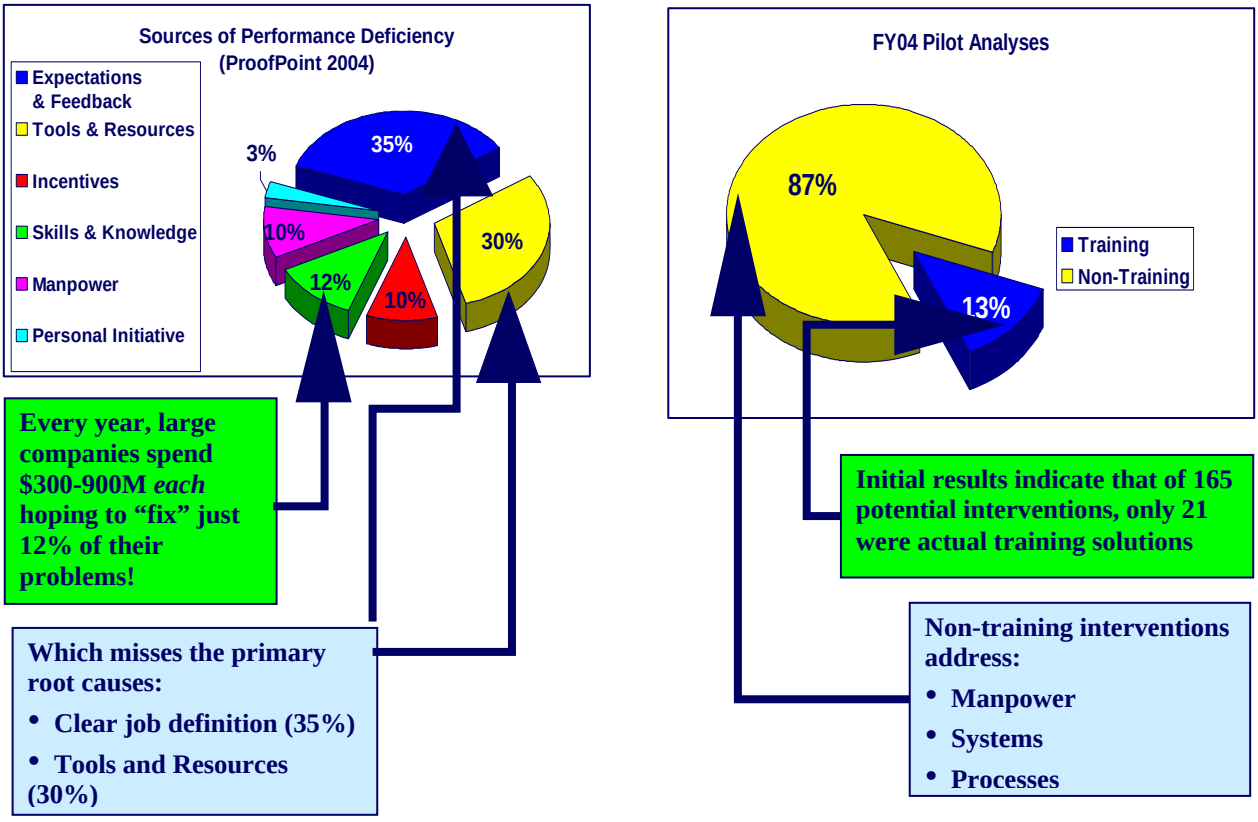


Figure 5 – The GAP-ACT Model in Context

More on the GAP-ACT Model can be found at http://home.att.net/~nickols/gapact.pdf

HPT in the U.S. Navy

In 2003, as a result of an executive review of Navy Training, the U.S. Navy officially stood up its Human Performance Center (HPC), headquartered in Norfolk, VA, with detachments throughout the country (a hub and spoke organization), to address and resolve all types of human performance problems, not just those believed to be caused by insufficient or ineffective training. In its first year alone, the following results were obtained and compared to Industry HPT results.



Lessons learned in that first year of operation include the following:

- The Sponsor typically needs to be educated on how to look at human performance problems to correct tendencies to:
  - Identify a symptom of the problem vs. the underlying issue
  - Provide a desired solution (which may not be the right solution)
  - Believe that training is the solution.
- Successful projects require stakeholder ownership, involvement, & collaboration.
- Field observation is key.
- Performance requirements are poorly articulated or do not exist.
- Cost of current performance deficiencies not readily available or not known.
- Critical data are lacking to support analysis. Must engage in time-consuming data mining.
- Potential solutions cross many organization boundaries.

Many successful projects have been conducted by the HPC since that first year of operation, with significant returns on investment and intangible benefits evident in project results. HPC has been working to collaborate with other U.S. Services, and even with international partners, to share the potential organizational payoff for instituting HPT. As indicated in the section that follows, HPC

sponsored an exploratory NATO Task Group to ascertain the value and process for implementing HPT within the NATO Alliance.

NATO's Human Factor and Medicine Panel 156: Utilizing HPT to Evaluate C2 Effectiveness

Why HPT in NATO?

Organizational performance takes on new significance in today's ever-changing global military landscape. In fact, all NATO partners share an important perspective on this issue - performance at the individual, team, and organizational levels are vital to success in achieving their mission. HPT can be employed to improve performance at any of these levels. Whether working with individuals, teams, or organizations, HPT focuses on results and accomplishments that are clearly defined through visible and measurable means. Meaningful metrics are critical to this process. They enable HPT professionals to define the gap between the desired performance state (the expected result or accomplishment) and the actual performance state, and can help determine the root causes for the disparity. Based on the cause analysis, interventions are selected, implemented and evaluated. This system is repeated until the desired performance level is attained. In short, this systematic performance improvement approach can provide NATO with a means of determining root causes for performance issues affecting readiness, and with a means of effectively resolving them. HPT can also be used for exploring opportunities and for planning to ensure that new projects have all potential problem areas (causes) addressed.

In January 2006, an exploratory team met to discuss how HPT might be incorporated within the NATO Alliance. It was determined that collaborative HPT projects within the NATO Alliance could be viable and effective. Subsequent to that meeting, it was determined that any new HPT projects should be launched within the C2 domain, since optimizing C2 operations is of vital interest to NATO.

NATO Foundations for HPT Analysis of C2

NATO Task Group HFM-156, "Measuring and Analyzing Command and Control Performance Effectiveness," was initiated in October 2006, as a first effort at introducing HPT to the NATO community. Although the group would not conduct official HPT projects, it would conduct preliminary work needed for the success of subsequent projects.

The group recognized that NATO's Research and Technology Organization (RTO) had begun to lay some of the important foundations needed for HPT analyses of C2. For example, Working Group SAS-050 (under the NATO Studies, Analysis and Simulation Panel) produced a comprehensive C2 Conceptual Reference Model. This model is designed to facilitate new, network-centric C2 approaches, and to improve upon the capability to analyze traditional approaches. It contains more than 300 variables and describes nearly 3000 relationships among those variables. This model represents the best thinking of international experts and provides the community with a conceptual model to employ in research, analyses, and experiments.

Another product, the NATO Code of Best Practice (COBP) for C2 Assessment (2002), was developed by the SAS-026 Working Group. The COBP is designed to facilitate the transition from C2 theory (i.e., the C2 Conceptual Reference Model) to operational practice. The COBP captures and enhances best practices and outlines a structured process for the conduct of operational assessment for C2. It provides an assessment framework, from concept development, through to assessment products and the dissemination of findings and conclusions. As the COBP explains, there are unique challenges to assessing C2.

> "C2 is special because it explicitly involves representation of the human component. The focus of military research and analysis has predominantly been on the physical domain. C2 deals with distributed teams of humans operating under stress and in a variety of other operating conditions. C2 problems are thus dominated by their information, behavioral and cognitive aspects that have been less well researched and understood. This focus creates a multi-dimensional, complex analytic space that involves multi-sided dynamics including friendly, adversary, and other actors, action-reaction dynamics and tightly coupled interactions among elements such as doctrine, concepts of operations, training, materiel and personnel. C2 issues are difficult to decompose and recompose without committing errors of logic. Moreover, the composition rules by which the various factors inherent to C2 interact are poorly understood except in arenas that have been previously studied in detail. Finally, the C2 arena is weakly bounded, with issues that although on initial examination appear quite finite, often prove to be linked to very high-level factors. The COBP is intended to assist the community in dealing with, and overcoming, the barriers to effective C2 assessment." (pp. 1-2, ASG-2)

The COBP states that relatively few specialized tools and methods exist for C2 assessment. Those that do exist focus on unique aspects of C2-focused research and are not generally well understood. The current state of practice in C2 analysis is that tools and approaches typically need to be developed for specific research agendas (NATO Code of Best Practice for C2 Assessment, 2002). HPT can fill in some, if not many, of these existing tool and methodological gaps.

While the C2 Conceptual Reference Model and COBP are important for guiding assessments of human performance in the C2 arena, what appears to be lacking is a commonly accepted, shared and accessible set of measures, metrics, methodologies, tools, and technologies appropriate for use in C2 evaluations. If multiple nations are participating in coalition exercises, they should leverage the best available approaches for assessing multinational C2 effectiveness. By analyzing what each country has to offer in terms of measures, metrics, methods, tools, and technologies, then making recommendations for their use or standardization, NATO could develop a reusable "tool set" that is accessible to the NATO partners and thus provides recommended, and to the extent possible, standardized measures and metrics. Such a "tool set" would:

1) Extend the work of the COBP
2) Greatly improve capabilities for evaluating and diagnosing performance deficiencies in the C2 arena
3) Improve efficiencies of C2 assessments (cost reductions)
4) Further bridge the gap from theory to practice.

More specifically, having meaningful and readily available C2 metrics would provide human performance technologists with the capability needed to identify exemplary C2 performance, diagnose performance gaps and root causes, and recommend solutions to improve C2 effectiveness. Recognizing this, NATO officially approved the establishment of HFM-156 to fulfill this mission, that is, to identify C2 measures, metrics, methods, tools, and technologies currently in use across the NATO Alliance. Once identified, those tools could support future HPT projects within NATO.

Facilitating an HPT Approach to C2 Assessment: HFM-156 Goals

HFM-156 is a three-year RTO Task Group (RTG), or technical team, whose term will span from October 1, 2006, until October 1, 2009. HFM-156 held its first meeting in Paris, France, on November 28-29, 2006, and its second meeting in Venice, Italy, on 6-8 March 2007. Current member nations include the U.S., France, Canada, Italy, and Sweden. Additional nations are welcome. The quality, completeness, and value of the HFM-156 products will be enhanced if more countries are represented in the group and are able to contribute to those products.

In scoping the three-year plan for HFM-156, three objectives emerged. First, the group would seek to identify deficiencies in the area of C2 performance assessment. Second, it would identify, examine, and catalogue C2 performance assessment tools (measures, metrics, methods, and tools) utilized by the NATO nations. The group would ultimately make these tools, or links to them, available in a web-accessible format that would support their reuse by the NATO countries. Third, the group would make recommendations regarding use of the tools and would share lessons learned gleaned from its analyses so that the nations can learn from each other's successes and failures in the area of C2 measurement and assessment. Included in those lessons learned would be special emphasis in identifying or recommending measures and metrics that will be useful as C2 evolves into the future. Areas of concern include the following:

- Technology has allowed real-time data and communication to flow further to the edge of organizations ("power to the edge"—where organizations interact with their operating environment to have an impact or effect on that environment (Alberts and Hayes, 2003). It would be useful to examine measures and metrics to determine the effects of having new levels of C2 now involved in real-time decision-making.
- Multi-cultural military operations may yield significant impact on such variables as command climate, attitude, values, ethnicity, age and gender differences. We don't yet fully understand the influence these variables present for C2 effectiveness. Again, there exists a need to identify measures, metrics and methods for evaluating these cultural effects upon C2.
- The line between "wartime" and "peacetime" is becoming blurred. Shifting from nation-on-nation wars with a definite beginning and end to fighting extended wars against borderless enemies affects C2. The missions are more complex and more delicate.
- Operations Other than War (OOTW) will continue to increase in frequency. Such operations are typically joint, multinational missions that increase the need for measures and metrics tailored for assessing multinational C2 effectiveness.
- At no other point in time has C2 changed more than during the careers of today's military leaders. Being able to measure commanders' adaptability involved in C2 would be valuable, and there is a need to ascertain what measures address soft skills such as leadership and adaptability.
- Finally, teamwork plays a critical role in C2 effectiveness. Understanding teamwork constructs and how to measure them is a relatively immature area, according to SAS 050.

Product Description

HFM-156 will produce, as its primary product, a "NATO C2 Assessment / Taxonomy Knowledge Base"—a repository, as such—that will capture the measures, metrics, methods, tools, and technologies being used by the member nations to evaluate C2 performance. New measures will not be created by this group, although gaps in C2 assessment capabilities will emerge as the database is being populated. The framework of the database is the comprehensive NATO C2 Conceptual Reference Model, produced by SAS-050. The 300 variables of this model have been designed into the database as a taxonomy, to which identified measures and metrics are being mapped. In other words, if a measure is capable of diagnosing the state of, or performance on, one or more of these 300 variables, then that measure is populated into the database, mapped to the relevant variable(s). Similarly, if a tool or technology can support research related to one or more variables, then that tool or technology would also be incorporated, again mapped to the relevant variable(s). Sources are provided for each measure, metric, method, tool, or technology included.

As the Knowledge Base is being populated, iterative analyses of apparent C2 assessment gaps will be conducted. As gaps begin to emerge, efforts will be made to search for measures or metrics to fill those gaps. If none are identified, then in the end, "white spaces" (i.e., empty spaces) will remain within the database. These "white spaces" will reflect where no measures, metrics, tools, or technologies have been

identified to support particular C2 variables. Additional attempts will be made to validate these assessment "gaps" via C2 subject matter experts. The RTG's Final Report will document its recommendations for measures or tools to be developed to fill those gaps.

In addition to the 300 variables and associated measures and tools mapped to them, the "NATO C2 Assessment / Taxonomy Knowledge Base" is labeling variables and measures with the following attributes:

- Warfare domain (i.e., physical, information, cognitive, or social)
- Scope of influence / impact, or Measures of Merit (MoM) classification
  MoMs are defined, according to the NATO Code of Best Practice (COBP) for C2 Assessment (2002), developed by SAS Working Group SAS-026, "in hierarchical levels related to each other, each in terms of its own boundary (pg. 91)." The COBP adopted the following levels of MoMs (pg .92):
  - Measures of Policy Effectiveness (MoPE), which examine policy and society outcomes
  - Measures of Force Effectiveness (MoFE), which characterize how a force performs its mission or the degree to which it meets its objectives
  - Measures of C2 Effectiveness (MoCE), which measure the impact of C2 systems within the operational context
  - Measures of Performance (MoP), which assess internal system structure, behavior, and characteristics
  - Dimensional Parameters (DP), which are tied to properties or characteristics inherent in the physical C2 systems.
- Input/process/output classification
- Root cause variables which the measures are capable of diagnosing

Levels of measurement (i.e., individual, team, unit, organizational) are also important when conducting C2 assessments. While some team distinctions are made within the variables provided by the NATO C2 Conceptual Reference Model, it is appropriate, as measures and metrics are populated, to notate whether they were designed to measure individuals, teams, etc.

So why are the attributes identified in the previous two paragraphs important to the HFM-156 effort? The answer is that they can be utilized to identify gaps in C2 assessment capabilities and to make recommendations for future actions needed. The attribute data can answer the following questions. Is there a scarcity of measures, metrics, or tools in one or more warfare domains? Is there a lack of measures within one or more MoM levels? Do we need more measures for evaluating inputs or processes or outputs? Do we need more measures capable of diagnosing specific root causes? Do we need more measures for evaluating teams or any other level of assessment? For the most accurate assessments, measurement specialists advocate multiple measures to "triangulate" upon true performance. So for example, it might be best to capture results for both processes and outputs, at both individual and team levels. Having this information available within the NATO C2 Assessment / Taxonomy Knowledge Base allows for filtering, categorization, and identification of available measures and tools along any of these dimensions (or any other dimensions to be added as work progresses).

Peer Reviews and Validation Efforts

HFM-156 plans at least two peer review / validation workshops to solicit feedback from HPT experts and from C2 experts. The first such workshop will be held in conjunction with the U.S. Coast Guard HPT Workshop in September 2007. The second workshop with C2 experts has not yet been scheduled, but will most likely occur in the summer of 2008. Experts will be queried about the tool and its content, about C2 assessment gaps they have experienced, and about those measures and metrics they believe would be useful as C2 evolves into the future.

Next Steps for HFM-156

What HFM-156 is not doing is creating standards for C2 performance or identifying exemplary C2 performance. Such standards are and will be needed for future HPT analyses within NATO. To the extent these standards and exemplars are lacking, they will need to be developed, at least for the specific contexts targeted by NATO for future HPT analysis.

Additionally, to the extent HFM-156 is unable, due to time or resource constraints (e.g., lack of representation from various NATO partners), to thoroughly exhaust every avenue for identifying C2 measures, metrics, methods, tools, and technologies, it is hoped that NATO will continue that effort through future RTGs. Optimally, future RTGs will be able to leverage the Knowledge Base to launch HPT projects (using any or all of the HPT models or tools described herein) to address C2 performance issues or concerns within the NATO Alliance.

The value of HFM-156's work lies in the benefits attributable to the Knowledge Base.

- First and foremost, it could serve as an HPT practitioner's tool to help diagnose root causes of C2 performance deficiencies and assist in remedying them.
- Secondly, it could enable the sharing of measures and tools across international boundaries and across military Services, thus increasing awareness of past and current measurement activities in the C2 arena. Such awareness could provide an informed ability to set performance standards, by referencing historical results. The use of existing tools and technologies may increase, thus optimizing development costs.
- Third, it should create efficiencies, in terms of labor and cost savings, with the reuse and standardization of measures and tools. Previous efforts can be leveraged. Standardization can facilitate performance comparisons across time. Existing measures may be tailorable to different contexts, warfare areas, or military Services.
- Fourth, by identifying the lack of measures and tools within specific C2 areas, perhaps new measures and tools will be developed and readied for future research. Or, if psychometric limitations or constraints (associated with specific measures) come to light, perhaps improvements will be made over time. The creation of measures, metrics, and tools that heretofore did not exist, and the continual refinement of measures, metrics, and tools over time, should heighten the effectiveness of future C2 assessments and continually move the 'state-of-the-art' ever forward.
- Finally, better assessments should lead to better diagnosis, which in turn, should lead to improved performance and mission readiness. Better assessments lead to better forecasting and trend analysis. And better data, resulting from more valid and reliable measures and metrics, should also lead to better decisions.

Although HFM-156's work is foundational and preparatory for HPT projects, it embodies many HPT methodologies and principles. Its efforts are analogous to (or perhaps a special instantiation of) Harless' FEA methodology and/or the organizational or mission analysis phase of the HPT model. The C2 Reference Model utilized by HFM-156 provides those variables important to the Customer (NATO/DoD). By identifying where gaps exist in terms of measures/metrics/tools to support those variables, the group is identifying a "performance problem" (i.e., lack of assessment capability) for which costs (monetary or otherwise) could be assessed for the Customer. There are other HPT parallels as well. The BEM is built into HFM-156's Knowledge Base, in that for each measure identified, the group is trying to indicate which root cause(s) the measure may be capable of diagnosing. Also, the HFM-156 analysis is by nature systematic and designed to bring efficiencies to the process of C2 assessment—by enabling reuse of measures, metrics, and tools, and by bringing more standardization and consistency to the measurement process. Having readily identifiable measures and technologies associated with specific dependent

variables of interest should facilitate future experimentation with C2 concepts. Measurement is critical to many phases within the Human Performance Improvement process (especially Performance Analysis and Evaluation), and the products to be produced by HFM-156 will support those critical components. They will enable base-lining of performance and comparisons to those baselines. By illuminating measurement deficiencies and gaps in the area of C2 assessment, the HFM-156 products may influence future efforts to remedy those deficiencies. By identifying measures and metrics that reveal root cause deficiencies, HPT practitioners can be more effective in selecting interventions to improve performance. In short, having the best tools in the HPT practitioner's toolbox, and the systematic application of those tools, is key to success in maximizing human performance, whether their application is in the C2 arena or elsewhere.

The Way Ahead: The C2 Performance Technology Model

Is there value in developing a C2 Performance Technology Model – the answer is yes. This work can build on the comprehensive HPT body of work developing and already in existence; and the comprehensive body of work championed by the Command and Control Research Program (CCRP). The C2 analyst already has systematic tools as evidenced, by among other efforts, the NATO Code of Best Practice for C2 Assessment. Recognizing, inserting, and using valuable holistic elements of HPT methodologies as evidenced by the HPT model and the Behavior Engineering Model amongst others can only strengthen these tools. And while the work of HFM-156 is moving forward a comprehensive framework begun by C2 analysts, we don't have to wait for that work to be done before we take additional steps to merge the strengths of the two disciplines. In fact the process has already unmistakably begun – the lines between business processes and C2 processes clearly are starting to blur in this information age. Agility and "Power to the Edge" as articulated in C2 literature have strong ramifications within today's business processes. And while the C2 analyst may have unique barriers to overcome in the form of an overt enemy striving to defeat his process, using models that seek to clearly differentiate between causes and symptoms, means and ends is invaluable in itself.

In Closing

Perhaps the most powerful thing that can be done in the world of C2 is to imbue systematic and systemic thinking hallmarked by HPT throughout the professional military corps and civilian analysts' profession. Other services would do well to emulate the U.S. Coast Guard which supports many of its mid-level officers to develop their HPT skills by sponsoring them to earn a Master Degree in Performance Technology offered by such schools as Florida State University, Boise State University, Indiana University, and University of Southern California amongst others. Offering HPT programs in military staff and war colleges would also be well worth the effort. Being versed in systematic and systemic thinking, so much so that it is almost a default thinking mode is invaluable for the military professional – for we know that in the execution of C2 in a real dynamic environment – being trained to search for causes and not symptoms (while the academic model builder is back home), is a powerful skill, perhaps the most valuable skill to navigate through the fog of dynamic military action.

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Appendix A

The Standards of Performance Technology listed here were developed by the International Society for Performance Improvement (ISPI). They can be found on the ISPI web site (2007) (www.ispi.org) and in the Forward of *Human Performance Technology Revisited* (Chevalier, 2004). While the principles are generally written in a business context, the underlying principal can easily transfer to the C2 environment:

> Human Performance Technology (HPT) has been described as the systematic and systemic identification and removal of barriers to individual and organizational performance. As such, HPT is governed by a set of underlying principles that serve to differentiate it from other disciplines and to guide practitioners in its use.
>
> **1. HPT focuses on outcomes.** Focusing on outcomes, or results, allows for questioning, confirming, and reconfirming that people share the same vision and goals, that job procedures support productivity, efficiency, and quality, and that people have the knowledge, skills, and motivation they require.
>
> The question to be answered is, "Where is there an opportunity or a performance gap, a difference between the present and the desired levels of performance?" Outcomes or results of an intervention will be measured to determine whether or not performance has improved. Sometimes it is necessary to challenge the assumed answer to a problem or the expected event or activity of an intervention and instead focus on the accomplishment or business need that is the client's true priority.
>
> **2. HPT takes a systems view.** Taking a systems view is vital, because organizations are very complex systems that affect the performance of the individuals that work within them.
>
> It is important to distinguish a systems approach from a process model. A process contains inputs and outputs with feedback loops. A system implies an interconnected complex of functionally related components. The effectiveness of each unit depends on how it fits into the whole and the effectiveness of the whole depends on the way each unit functions. A systems approach considers the larger environment that impacts processes and other work. The environment includes inputs, but, more importantly, it includes pressures, expectations, constraints, and consequences.
>
> **3. HPT adds value.** While HPT requires a focus on intermediate goals (such as improving quality, customer retention, and cost reduction), its success is measured in improvements in desired business outcomes (such as sales, profitability, and market share). Alignment of individual performance to intermediate and business outcomes is critical to the HPT methodology. Measurement of results at both of these levels serves two important purposes, that of communicating the importance of what is being done while also assessing the amount of performance improvement.
>
> **4. HPT establishes partnerships.** Performance improvement professionals work in partnership with clients and other specialists. A collaborative effort involves relevant stakeholders in the decision-making process and involves working with specialists in their areas of expertise.
>
> Working collaboratively includes sharing decisions about goals, next steps to take in the process, and implementation strategies as shared responsibilities. Partnerships are created from listening closely to clients and colleagues, trusting and respecting each other's knowledge and expertise.
>
> **5. Be systematic in the assessment of the need or opportunity.** Analysis occurs in the beginning of the project. Needs or opportunity analysis is about examining the current situation at any level or

levels (society, organizational, process, or work group) to identify the external and internal pressures affecting it. This process will determine the deficiencies or performance gaps that are to be remedied. The output is a statement describing the current state, the projected future state, and the rationale or business case for action or non-action.

6. Be systematic in the analysis of the work and workplace to identify the cause or factors that limit performance. Cause analysis is about determining why a gap in performance or expectations exists. Some causes are obvious (e.g., new hires lack the required skills to do the expected task). This step in the systematic process will determine what should be addressed to improve performance. The output is a statement of why performance is not happening or will not happen without some intervention. Job task analysis includes the identification of the important tasks that employees must perform and the knowledge, skills, and abilities to perform them. The output is performance objectives that describe the desired performance, delineate the conditions under which the performance is done, and identify the criteria for successful performance.

7. Be systematic in the design of the solution or specification of the requirements of the solution. Design is about identifying the key attributes of a solution. The output is a communication that describes the features, attributes, and elements of a solution and the resources required to actualize it.

8. Be systematic in the development of all or some of the solution and its elements. Development is about the creation of some or all of the elements of the solution. It can be done by an individual or a team. The output is a product, process, system, or technology. Examples include training, performance support tools, a new or re-engineered process, the redesign of a workspace, or a change in compensation or benefits.

9. Be systematic in the implementation of the solution. Implementation is about deploying the solution and managing the change required to sustain it. The outputs are changes in or adoption of the behaviors that are believed to produce the anticipated results or benefits. This standard is about helping clients adopt new behaviors or use new or different tools.

10. Be systematic in the evaluation of the process and the results. Evaluation is about measuring the efficiency and effectiveness of what was done, how it was done, and the degree to which the solution produced the desired results so that the cost incurred and the benefits gained can be compared. This standard is about identifying and acting on opportunities throughout the systematic process to identify measures and capture data that will help identify needs, adoption, and results.