Things That Help Us Perform: Commentary on Ideas from Donald A. Norman

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I read Donald Norman's (1993) book *Things That Make Us Smart - Defending Human Attributes in the Age of the Machine* hoping to find gems of wisdom that might allay my uneasiness about consulting on performance support systems. I did, and—at the risk of a heavy indulgence in narcissism—let me explain. I consult at the earliest possible moment to ensure that systems enable performance—*business* performance—through competent human performance. This is done in context with a rapidly changing business environment, a decline in the availability of "service sector" candidates, and a traditional training and education mentality.

If you're reading this journal, then you know the hype: *Electronic Performance Support Systems (EPSS) enable performance of tasks with a minimum of external intervention, without training in advance, but guarantee that learning takes place albeit secondary to task completion.* (Whew!) So what must I be? A graphical user interface (GUI) design expert? A business process modeler? An educational technologist? A hypertext engineer? A knowledge engineer? A human factors engineer? Well, the answer is, "Yes!" to all. Herein lies my uneasiness.

With the exception of "human factors engineer," all of the other hats I wear drag me away from the human focus, which is the stuff of EPSS. The GUI design hat draws my focus to consistent menus, controls and icons; the process modeling hat underscores cost, utilization, and full-time-equivalents; the hypertext hat leads me to nodes, links, anchors, jumps, and so forth. In other words, almost all of the disciplines that are apparently appropriate to EPSS development force designers to focus on issues that are, at best, necessary but not sufficient to ensure human performance. *That* is the source of my uneasiness; Donald A. Norman is the source of my salvation.

Things That Make Us Smart eloquently defends human attributes in the age of electronic systems. Reading Norman is like peeling an onion layer by layer to uncover the cognitive underpinnings of the aforementioned uneasiness and to suggest a paradigm in which we as designers can properly focus on the human being and get systems into production. Obviously, I'm a disciple: The temptation is to *summarize* rather than review *Things That Make Us Smart.* In fact, I shall attempt both in order to do justice to this fine work and to assist you, my colleagues and soulmates, who are in need of salvation.

Norman points out the following:

- There are two kinds of cognition—experiential and reflective—which categorize the business

tasks at hand and have enormous implications regarding task structuring in design.

- There are three kinds of learning—accretion, tuning, and restructuring—that must be mapped to the two kinds of cognition and which, in turn, have enormous implications for those of us engaged in developing systems which ensure that task completion is primary, learning is secondary to the task at hand.
- Performance is dependent primarily on the cognitive artifacts of the context - and without good ones human beings perform poorly or cannot perform at all.

Norman points out that, since what we view on a computer screen is a virtual environment consisting of *contrived* cognitive artifacts, we as designers make or break performance by how carefully we construct these artifacts. There are essentially three design principles to follow:

1) The representation must match the task!

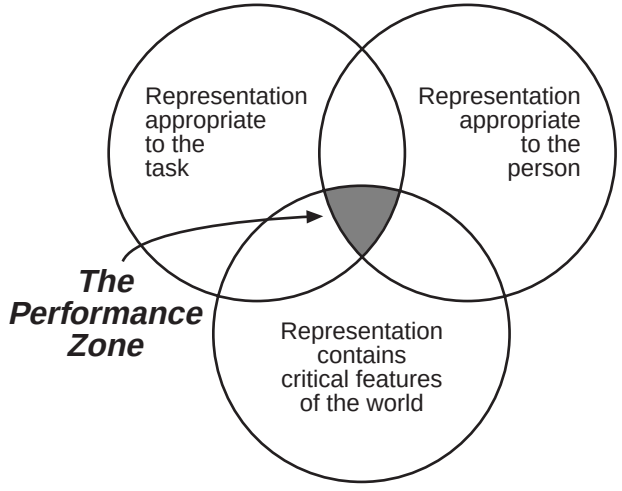
2) The artifact must match the person!

3) The passive constraints that are imposed by artifacts must **focus** (abstract) the critical features of the "world!"

If systems are designed according to these three principles, then performance is virtually guaranteed. If the representation does not follow one or more of these, then users are faced with "training" programs, frustration, and poor performance.

These principles—these "things that make us smart"—are indeed the things that enable performance. If you are a designer, I suggest you make a copy of Figure 1, and keep it handy as you read Norman's book.

Figure 1. The Performance Zone.



What is most impressive about *Things That Make Us Smart* is the plethora of examples from which the EPSS developer can infer analysis and design processes. Very simply, Norman has embodied his principles in the presentation. On the issue of physical constraints of artifacts enabling tasks, he poses a problem and gives equivalent solutions—some of which require knowing one simple rule while others require learning many rules, performing calculations and the like.

Consider, for example, constructing a two-person competitive game that employs strategy. Norman poses the following (page 53):

> "Let's play the game of '15'. The 'pieces' for the game are the nine digits-**1, 2, 3, 4, 5, 6, 7, 8, 9** . Each player takes a digit in turn. Once a digit is taken, it cannot be used by the other player. The first player to get three digits that sum to 15 wins."

This representation of the game requires the players to know four rules, to keep track of which numbers have been chosen, and (argghh!!!) to perform mathematical calculations! (I have posed this game as stated above to groups of adults—who have either given up in frustration, or who have asked for the rules repeatedly, written them down, or searched for calculators.)

Now consider a "cognitive isomorphism" of the game (Figure 2), a version in which a game board is employed to assist the players.

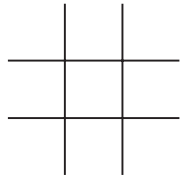
All rows, columns and diagonals of the board add up to 15, thus the computational task is removed from the game. It becomes a simple matter of players alternately choosing numbers - and crossing their choices out with unique symbols - until one gets three numbers in a row.

Figure 2. Game board for game of "15."

4	3	8
9	5	1
2	7	6

Think about it. The mathematical attributes have been replaced by the physical constraints of the game board; in fact, the numbers are irrelevant. You can replace this game board with the one in Figure 3 (a second "cognitive isomorphism").

Figure 3. A better game board for "15."



Clearly, if players use **X**'s and **O**'s to make choices the game is ticktacktoe.

What a beautiful example! Here are three equivalent representations of the same problem. The first requires learning, memorizing, and computing - not "fun" at all: *The representation fits the task, but is not appropriate for most people and contains more than the essential elements of the world*. The second case is much easier - but the numbers actually obscure the game's focus: *The representation fits the task and is appropriate for most people, but con-*

tains more than the essential elements of the world. The final case—the familiar ticktacktoe board—demonstrates clearly that the physical constraints imposed by the artifact can quite elegantly enable task completion (*fits the task, fits the person, and contains only the essence of the world).*

Norman provides a number of similar examples: the Official Airline Guide (pp. 55-59), the Medical Prescription dilemma (p. 63), Towers of Hanoi, Oranges, and Coffee Cups (pp.

Table 1
Common Violations of the Three Design Principles

Layer upon layer of menus	*The representation (of workflow) is not appropriate to the task.* The system has hidden the essential item beneath a stack of "screens" when, in reality, a worker would actually hold the piece of paper (represented by the buried screen) in hand *first,* then take appropriate action.
Hidden "shortcuts" (like cryptic commands, strange key combinations etc.)	*The artifact is not appropriate to the person*. A new or inexperienced person does not know these features—nor can an experienced person necessarily keep them all in his or her head!
Cryptic field labels	*The representation is not appropriate to the person nor does it contain only critical features of the world*. Such cryptic artifacts are representations of a *machine-centered* world of yesterday—a time when hardware constraints (e.g., few bytes of RAM) forced us to abbreviate.
On-line "help" - the *War and Peace* variety	*The representation is not appropriate to the person* (too much to read!), contains MUCH more than the critical features of the world - and may not be appropriate to the task at *all* ("...it was a dark and stormy night...").

84-89), and many others. In each case the reader is reminded of the three principles (Figure 1) and how to apply them. I would stress, however, that *Things That Make Us Smart* contains no specific reference to EPSS, nor are there many specific examples of task representations by virtual artifacts within computer interfaces. Nonetheless, we can (as human beings) abstract the lessons and transfer what we learn to the world of EPSS design with ease. (This consultant had no trouble; and I would guess that Norman would expect this to be so!)

Let me further emphasize the application of Norman's examples and principles to the EPSS development world by reminding you of the nightmares: layer upon layer of menus, cryptic field labels, hidden "shortcuts," months of "training," and online "help" that rivals *War and Peace*. If we examine such systems in light of *Things That Make Us Smart*, we conclude simply that one or more of the Figure 1 principles have been violated. Table 1 discusses examples of common violations.

The lesson learned for EPSS designers is that Norman's principles, *all three*, must be reflected in each and every task representation. It is not enough to have consistent GUI design principles to ensure performance: They are necessary, but not sufficient to ensure the "big three." (Sure, radio buttons are nice, because they are always radio buttons...but do we not create memory burdens when users have to remember *which* radio buttons do *what*?) It is not enough to employ principles of "mapping" information or hypertext engineering to ensure performance: They are necessary, but not sufficient to ensure the "big three." It is not enough to employ best practices in data modeling or workflow analysis to ensure performance: They are necessary, but not sufficient...

I've learned from Donald Norman to include "'morphing" activities in EPSS analysis and design sessions. For example, if the task at hand is for a financial analyst or customer service representative to answer a telephone, find the customer in the computer system, then change the distribution of investments or beneficiaries, we must brainstorm SEVERAL ways of representing the task. We must identify all cognitive artifacts of the physical world and invent meaningful virtual artifacts in the computer world that are appropriate to the tasks and the person. We must count the things we are requiring the worker to know in order to recognize the artifacts, and ask: Are there too many rules and facts—like in the first representation of ticktacktoe, or too many levels of menus (beneficiary change, investment type, procedure, customer...)? Are we introducing deterrents to performance (like math calculations when a simple table will do)? Have we presented *only* those features of the world that are essential (like saying 'select customer' instead of 'open file')?

In other words, the many "hats" I spoke of early in this review all contain in their methodologies aspects of ensuring performance (necessary conditions for the big three). But one must construct for performance *qua* performance—by virtue of what helps people perform. We must engage the minds of designers, business experts, technical experts, *perform-*

ers—in the activities of optimal representation (i.e., ensuring the "big three").

Things That Make Us Smart explores collaboration among human beings, which is often a significant contributor to performance, and which sometimes suggests that the optimal new design must retain artifacts of the old. In Chapter 6, "Distributed Cognition," Norman mesmerized me with examples from the airline industry (pp. 140-144: yoked control wheels in cockpits), the nuclear industry (the Three Mile Island accident), the Paris Metro, and others. In each case he builds on the notions of the "big three" by introducing additional aspects of human beings (e.g., how cross-chatter on the phone lines of a ship actually aids navigation and rapid error detection and correction). These additional aspects are explored in Chapter 5 - the Human Mind, to provide us (gently) with the necessary underpinnings.

Things That Make Us Smart *helps us to look into the future to see what awaits us, and helps us to keep focus on appropriate uses of technology while keeping our designs* human centered *rather than machine centered.*

By the conclusion of these sections I was thinking hard (and productively) about a recent customer service EPSS design in which several "extremely necessary and useful" (yeah, my quotes) components were ignored by the users. It seems that while including a rich hypertext of business information, I left out some essential elements of the world: talking over the workstation barriers, decking the walls with personal notes, and the like. Indeed, I probably missed all of the big three—but we had one hell of a hypertext!

Finally, *Things That Make Us Smart* helps us to look into the future, see what awaits us, and helps us to keep focus on appropriate uses of technology while keeping our designs *human centered* rather than machine centered. In my view, these latter sections reinforce the "big three": they illustrate more varied and subtle ways in which the principles might be applied. They enhance our understanding of how people perform and how to design for performance. (During the reading, my mind flashed to that most powerful scene from the movie version of *Elephant Man*, in which an angry crowd corners the protagonist in a lavatory as he screams, "I am a human being!!")

In the final analysis I believe that Donald Norman probably has (and we as designers of human centered systems which utilize technology should probably have) a large sign that states:

"It's the *RepresenT Ation,* Stupid!"

And for those who thrive on artifacts such as little sticky notes to remain on target, I leave you with a collection of "Norman-ese"—and encourage you to *not* take them out of context, but to read *Things That Make Us Smart* and incorporate its spirit into your EPSS design methodologies.

> Design should be like telling a story. The design team should start by considering the tasks that the artifact is intended to serve and the people who will use it. (p. 105)

> Want to guarantee error? Then devise tasks that require using the memory for details, that require devoting extended periods of attention to unchanging situations. If the environment consists of rows of similar-appearing controls or displays, error in reading or operating them is almost guaranteed to happen. (p. 138)

> The power of information artifacts is that they provide an unrivaled opportunity to enhance our lives. The danger is that they can stress our everyday existence. (p. 105)

> The trick in designing technology is to provide situations that minimize error, that minimize the impact of error, and that maximize the chance of discovering error once it has been committed. The human-centered way.(p. 138)

> Is there a way to transform the hard technology of computers...into a soft technology suitable for people? Yes, I think so. The correct approach...is to start with the needs of the human users of the system, not with the requirements of the technology. (p. 237)

> A place for everything and everything in its place—if only you can keep track of the places. (p. 159)

> "What can technology do to help?" is almost always the wrong question. (p. 152)

> Stories are important cognitive events, for they encapsulate, into one package, information, knowledge, context, and emotion. (p. 129)
> [*Ahh, if only each system told a story... —GJD*]

> **Grudin's law** : When those who benefit are not those who do the work, then the technology is likely to fail or, at least, be subverted. (p . 113) [Re: voice messaging systems.]

> The new-fashioned information artifacts take on arbitrary shape and form. There is no natural mapping, no natural principles of operation. The critical operations all take place invisibly through internal representations. If we are able to use these artifacts easily and efficiently, the designers have to provide us with assistance, with understandable, coherent structure. We are in the hands of all designers, who have the power to make the artifact meaningful, to provide substance and richness, and to make its use support the activities of interest. The best of the artifacts will become invisible, fitting the task so perfectly that they merge with it. They will be a delight to use. (p. 105)
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> [***Amen.***]

References

Norman, Donald A. (1993) *Things that make us smart - Defending human attributes in the age of the machine.* Reading, MA: Addison-Wesley.

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