Zen and the Art of Human-Systems Integration: Presidential Address to the Human Factors & Ergonomics Society

Francis T. Durso

Georgia Institute of Technology

Boundaries both define us and constrain us. Knowing where one thing ends and another begins is also important in how we relate to others. Where does the human end, and technology begin? Where does the sociotechnical system end, and context begin? Where does our discipline end and the discipline of the operational expert we study begin? Where does the lab end and the field begin?

In 1974, Robert Persig wrote Zen and the Art of Motorcycle Maintenance. On the surface, it's a story about him, his son, and a couple of friends on a motorcycle trip from Minnesota to Northern California. In reality, it's a philosophical look at Quality and value. In fact, it stands today as the most widely read philosophy book.



In that book, Persig spends much of the time talking about people and technology, romantic views versus rational views. He talks about his two traveling companions who deal with technology as something very much apart from themselves—the romantics. He talks about motorcycle repairmen—technologists he calls them—who view technology as things to be worked on. And he talks about the Zen approach, where people and technology are one part of the same system. Persig tries, on this motorcycle trip, to integrate all of these views to appreciate being in the moment.

Now, I'm no Zen master, but it's clear that Zen views the world as a system.

And therefore when Persig talks about people and technology he captures much of what the people in this room subscribe to.

For example, Persig argues that reductionism is

limited and that a systems view is the way to true understanding. Most of us in this room subscribe to a systems view, at least when it comes to looking at the operator and her interface.

To Persig,

The machine that appears to be "out there" and the person that appears to be "in here" are not two separate things. They grow toward Quality or fall away from Quality together."

-Robert Persig, Zen and the Art of Motorcycle Maintenance

I'll spend the next few minutes talking about the Zen of HSI by asking about the connections and boundaries of our discipline. At the end, I'll try to keep with the Zen tradition by asking a provocative, perhaps bizarre, question that will hopefully force us to reflect on our discipline, how we do business, and how we see ourselves and the world.

When we think about things—people and technology for instance-- as a system at some level is to think of them as one thing. Zen Masters understand that:

"It is just your mind that says you are here and I am there, that's all. Originally we are one with everything."

--Shunryu Suzuki, Zen Master

We'd call it a system-of-systems.

We see people and technology as a sociotechnical system but really we see that sociotechnical system as if each subsystem—the person and the technology—remains identifiable, extractable. In some ways we see it as a marriage between person and machine.



My augmented cognition friends, see it a little different but still a union between person and machine.

But I think trying to hold on to the separateness of the person or even of the machine when we look at a sociotechnical system is misleading. There is only some of

the original person left when we put her in a sociotechnical system.

I think we'd get a true picture of a sociotechnical system if we used a deconstruction metaphor rather than a construction metaphor. Rather than thinking of a sociotechnical system as being made up of a person added to technology, we can think of the independent person as something extracted from a system-of-systems, actually many systems-ofsystems, some of which are sociotechnical. So we should start with the sociotechnical system and then if we want to think of the person or machine separately we should think of it as a divorce that "rents asunder" what naturally is a union of two.

Extracting Romeo from Romeo and Juliet leaves less than Romeo. We cannot understand Romeo without Juliet. If we try, we discover only the original Romeo, the one who never met Juliet. It is not the Romeo we care about.

Appreciating that technology and people are inextricably connected has consequences for how we should view ourselves and how others should view our discipline of human factors. My good friend and colleague Howard Weiss has been advocating that to understand the modern human in any serious way requires an understanding of humans as interdependent on technology. He argues that our relationship with technology is defining, and that any psychology would have to account for that. That's an exciting and provocative position. It means that what we study as human factors professionals is an important part of what makes us human and as such should be



a central aspect of modern psychology. Instead, mainstream psychology has human factors as an afterthought, if it is thought of at all. Psychology at its core requires us to understand how people exist, function, and thrive in a technological world.

If the sociotechnical system is one thing that is central to humanness, where does the sociotechnical system end? Should it just be the person and the technology at that moment, and everything else be considered the context in which the sociotechnical system is embedded? Since the beginnings of our profession, the discipline has become increasingly strident in arguing that the answer to that question is NO.

The figure below has my take on our disciplines' road to enlightenment.



Frederick Taylor and scientific management were primarily concerned with how long it took for work to happen. His concern was about efficiency from management's point of view. The Gilbreths broke with Taylor and added concern for the worker.

Consider this figure from Moray (1999). Here, Moray shades the part of the sociotechnical milieu that cognitive psychologists and cognitive engineers typically consider. As a cognitive type, I would certainly not deny the influence of the outer concentric squares, but I wouldn't necessarily do anything about them. They would be just contextual influences that I could leave to the reader to fill in.



Indeed, as Moray told us,

There are no such things as context free laws when we look at people in the uncontrolled worlds in which they live.

--Moray (1994), Proceedings of HFES

From Moray (1999), Industrial Systems. In F. Durso, et al (Eds)., *Handbook of Applied Cognition*.

As time went-- on more was added to what we thought was an appropriate focus of HF.As we continue, we see the addition of macroergonomics—the inclusion of organizational culture, for example. Now organizational culture is more than context. It is something that is often part of the focus.

Another broadening of sociotechnical systems can be traced to the military. This version of Human-Systems Integration considers Human Factors Engineering as just one subdiscipline of a number of subdisciplines that should be considered. Depending on the country you're from and the branch of the military you're talking about, HSI comprises 7 plus or minus two disciplines.

Virtually everyone includes these six domains: Human Factors Engineering, Selection, Manpower, Training, Safety, Occupational Health. All of the branches of the military add Survivability. The Navy uses all nine, including habitability. For the military, these dimensions are part of the procurement process. The 9 dimensions in the slide are used by the military to help guide development and acquisition of new technologies.



But explicitly adding these other considerations is beginning to be considered as appropriate expansions of what we should be looking at when we study sociotechnical systems. The National Research Council of the National Academies has recently repositioned the "Committee on Human Factors" to the more permanent Board of Human Systems Integration. And the American Psychological Association has in production a new Handbook of Human Systems Integration that follows Booher's classic volume. The APA volume reports an expansive view of traditional HFE topics, but also goes beyond those traditional limits to look at these other dimensions.

But as we expand human factors, when should we stop? Is everything ultimately really Society's fault? Where does the sociotechnical system stop and context begin? Of course, that context is a set of systems as well, but researchers must decide at what point beyond the system of interest do they stop a systems analysis and merely recognize that while there are additional influences, it is best to consider those as a context not subject to detailed analysis. Wilson (2014) argues for something like the stopping rule from task analysis to help make this demarcation. Thus, what is one person's embedding system is another's context, but where this line is drawn is worthy of serious thought.

I would also suggest that each of us routinely go through an HSI checklist. We should at least consider the other dimensions as we ponder our sociotechnical design systems. Even if I had a very narrow focus—say a rail engineer with a newly designed display with positive train control, I should at least—at least—ask questions like: If I make that design recommendation:

- Will the legacy workforce be able to handle the new display or will there additional training be required?
- Should we change our selection criteria? What's the market like for those folks?
- Will one person in the locomotive cab still be sufficient? What about the manpower requirements at dispatch or other more remote sectors of business?
- How does the engineer feel about doing the job now? Is there more stress? A feeling of diminishment?
- What is the TOTAL COST going to be if my sponsor adopts my suggestions?

I am arguing that doing science or engineering in this view of HSI is all about tradeoffs. Decisions about what I leave out and what I include because it has consequences for the other

HSI dimensions. The sponsor will surely be making these tradeoffs, and I think if we can anticipate these by going through this type of HSI checklist we'll be more successful at being accepted—especially early in the design process.

I argued a moment ago that the way we see the sociotechnical system contributes to our marginalization in traditional psychology. Similarly, I think that when we constrain the sociotechnical



system to exclude, ignore, or relegate to context, dimensions like selection, manpower, health, and training we contribute to the view of industry and other sponsors that we are a marginal player. I think this is why we are often not embraced by sponsors. It is tempting to say that "industry just doesn't get it" but in reality we have to recognize that the system in which our sponsors live is much bigger than the system in which we often work. Until we start to consider that larger system, we will continue to be marginalized.

It's ironic that we use the system concept to do our jobs, but we forget we are part of a system interacting with other systems as we do our jobs. In fact, when we do not realize that the system we bring with us is only one of the systems involved, other issues will continue. One example is what a friend of mine calls "the ugly baby;" someone has spent the last year putting together a program or a prototype and we, in our enthusiasm for our discipline, explain how they gave birth to a monster and that it's a good thing they called us before it grew into the antichrist. When we are invited to a christening, our first reaction should not be to perform an exorcism.

So where does the HF expert end and domain expert begin? When we enter a domain, we enter with a particular set of skills and knowledge into *another* system in which experts have a different set of knowledge and experience. Now, we believe when we enter that system, that what we have to do is learn a little about the domain, enough so that we can apply our knowledge about human factors. But, if we recognized we were entering a system, we'd realize that they think they can take learn a little about human factors, enough so that they can apply their knowledge about the domain to produce a better way of doing things. And, indeed, Emelie Roth has some nice examples of domain experts whipping up improved interfaces without our help



Unfortunately for us, we have another problem. The contributions we make are often not noticed. We are at our best when we are invisible to the users of our work. The planes that land safely day in and day out. The rear end collisions that don't happen because of high-mounted center brake light or raised awareness about cell phone use. The nuclear plant that ends the day without incident. The pacemaker properly installed.

I'd like to end my Zen take on Human Systems Integration by asking the promised provocative question that might help illustrate some of the points in this presentation. OK, so it's not as revealing as the question, "What is the sound of one hand clapping?" but it's something I can at least begin to wrap my mind around.



Years ago I was the University of Oklahoma's representative to a conference held by the Sloan foundation. The purpose of the conference was to explain to faculty how virtually every course, even those in the humanities, could be improved by integrating technology. One person for example gave us a history lecture, punctuated with examples like how the stirrup allowed riders to lean over farther than their opponents to strike the enemy. It also allowed less athletic folks to join the fight and allowed archery from horseback.

Another lecture asked "Why are surgical gowns green?" People in the audience offered their answers, which the expert countered. To hide the blood...then why aren't they red?

Fascinated, I've done more research into this—more than I should at least. Scrubs were originally white. Nice and clean. The periodical "Today's Surgical Nurse" says that at the turn of the last century, an influential surgeon switched to green. The story is that he thought it would be easier on a surgeon's eyes.

Indeed, look at the color wheel. After a hard day of staring at red bloody insides, green



people wear).

can help for a couple of reasons. Looking at green can be a refreshing respite from staring at red. The surgeon can look back inside at the bloody red subtleties with renewed sensitivity. It is also true that staring at a color for prolonged periods under bright light can produce opposite color afterimages. These afterimages would be most pronounced on the bright white of cleanliness, but relatively invisible against a backdrop of an opponent color—in this case green.

This part of the answer I think illustrates a couple of things about systems. It reinforces the notion that there can be clear, if subtle, interactions between people (in this case our visual system) and technology (what

The other thing is that the green gown caught on and was widely adopted. It's a great illustration of the fact that the domain expert with a little caring about improving his or her job can make important human factors contributions. And no doubt it caught on in part because it was promoted from within. I sometimes wonder if a human factors professional had suggested green, if everyone would still be wearing white? So, no data, no experiments, just someone on the inside with a good idea.

Now, green has also been offered after some serious data collection as the preferred color for fire trucks. In fact some of this work by Solomon can be found in our own EID. Indeed, some departments did adopt the "better" fire truck. But it didn't catch on like green surgical gowns did. In fact, some departments that adopted green are going back to red. Better data?

Well they did get data, but it involved asking firemen if they would rather go back to red. So not exactly data on the ability to detect the target.

Now that the basic lab data on detection of lime green was out in the field, with real experts from another system, it confronted other factors besides safety, and it lost.

Let me get back on our philosophical motorcycle and revisit Persig:

If a factory is torn down, but the rationality which produced it is left standing, then that rationality will simply produce another factory....There's so much talk about the system. And so little understanding.

-Persig, Zen and the Art of Motorcycle Maintenance

And finally a quote I think we can all relate to about systems inside systems.

I have yet to see any problem, however complicated which—when looked at in the right way—did not become still more complicated. --Poul Anderson, Science Fiction Author

THANKS MUCH!

Frank can be reached at frank.durso@gatech.edu, www.CEL.gatech.edu, and 404-894-6771