FELLOW PROFILE

Name: **James D. Baker**

Degrees, certifications, etc.: BA, MA, PhD, CPE
West Virginia University
The Ohio State University
The Catholic University of America
Certified Professional Ergonomist,
(CPE) Certification # 1521

Current status: Retired but still do some limited consulting

Home page (optional): None

Biography (How you got involved in the field, your major career activities and milestones):
I started as a Behavioral Psychologist and as such I have run more than my share of rat-maze studies; pigeon conditioning studies and a variety of other animal learning studies. My hero was Harry Harlow so my master's thesis was the study of the learning-to-learn phenomenon in a sub-primate -- the raccoon. But while a student at Ohio State I took a course from Paul Fitts and later worked on an Air Force Wright-Patterson Air Development Center project in his Aviation Psychology Laboratory. My interest then shifted to what was known at that time as Engineering Psychology. I was hooked.

It was also about this same time that my G.I. Bill was about to run out; I had just gotten married, and I needed a job. So I contacted an old mentor and friend from my days at West Virginia University, Dr. John Townsend. John had left academia and was then the Head of the Air Force Intercept Pilot Research Unit at Tyndall AFB, FL. I asked him if he knew of any jobs available and he said yes if I knew anything about computers. I told him I did since the Wright-Patterson project I was working-on was examining the effects on pilot tracking behavior while doing multi-channel tasking and the tracking part of the effort was driven by an analog computer. Consequently, I wound up being hired in 1957 as a research psychologist and assigned to the SAGE Operator Research Unit working in MIT's Lincoln Laboratory at Hanscom Field, Bedford, MA.

There I became part of a very large government/industry research and design team tasked with putting together a system that no one had ever tried to build before – the world's first interactive digital computer system called SAGE (Semi-Automated Ground Environment). And it was there that I encountered my first dash of real-world reality … I had been proficient as an *analog* programmer and that was why I was hired but now I was being asked to do something that few people had ever done before … program a *digital* computer. So my first assignment was to learn to program in machine code. MIT's Lincoln Lab had at the time an experimental prototype computer called Whirlwind I and that is what we originally worked with.

SAGE (designated by the USAF as System 416 L) was essentially a computerized automated control system for tracking and intercepting enemy bombers. When completed it would be used by the North American Air Defense Command to protect the entire United Sates. The heart of the system was the AN/FSQ-7, computer manufactured by the IBM Corporation and that particular machine was then, and still is, physically the largest computer ever built. *Each* machine (two for each of the 25 SAGE sectors needed to protect the entire U.S.) employed 55,000 vacuum tubes; required a half acre of floor space and weighed 275 tons. To cool the tubes enough water was pumped through it each day to supply the daily needs of a small-sized U.S. town. To get some idea as to the size and complexity of the overall SAGE system click on to the following link and look at an old USAF film about SAGE. http://www.youtube.com/watch?v=06drBN8nlWg

The SAGE system was operational until 1983. Parts of it were then dismantled and sent to *The Computer Museum* in Boston. In 1996 the remainder was moved to Moffett Federal Airfield for storage and is now in the collection of the *Computer History Museum* in Mountain View, California.

But trying to do research on computers this size, and with our research efforts wedged-in between critical missions, led many of us to the realization that what we needed was a smaller computer that could be used in a laboratory setting. Among the people then working at the MIT Lincoln Laboratories were two engineers Ken Olsen and Harlan Anderson who decided to do something about it so they found start-up money and leased space at an old woolen mill in Maynard, Massachusetts. There they started the Digital Electronic Corporation and built DEC mini-computers. The Decision Sciences Laboratory, which I was then part of, had enough money in its budget to buy a mini-computer but there was a Congressional freeze on purchasing computers at that time because IBM had by then become the sole source for computers and the fear of a monopoly raised its head. To get around this problem a colleague of mine at the Decision Sciences Lab, Dr. Charlie Brown (true name), rewrote the purchase order to indicate that we were not buying a computer but rather a laboratory tool that would programmatically *p*resent stimuli, collect *d*ata and *p*rocess it. In that way we were able to purchase the *first* DEC computer ever built and in the paperwork submitted with our requirement the request was shortened to the purchase of a DEC PDP-1.

Subsequently, I and several of my colleagues were sent to the DEC woolen mill plant to learn how to program it. And with this acquisition we became, if not the first, at least one of the earliest computerized human factors laboratory's in the country. One other bit of early PDP-1 computer history merits comment. The USAF wouldn't accept hardware items that were not painted Air Force Blue. So DEC had to purchase a fifty gallon drum of USAF acceptable blue paint and every DEC computer thereafter was painted Air Force Blue until version PDP-9 … which is when they ran out of that drum of blue paint.

Our PDP-1 was the first computer in Digital Equipment Corporation's PDP series and was built in 1959. Follow-on PDP-1's are famous for being the computer that created a "gypsy programmer" culture at MIT, BBN and elsewhere. The PDP-1 was also the original hardware for playing history's first game on a minicomputer, Steve Russell's *Spacewar!*. The Decision Sciences Laboratory's original PDP-1 computer is now in the *Computer History Museum.* You can learn more about this historic machine by going to http://pdp-1.computerhistory.org/pdp-1/

While a member of the USAF Decision Sciences Laboratory I took part in the design process of a number of follow-on USAF Command and Control Systems (or L-Systems as the USAF designated them) including work on the 425L NORAD system that is still in operation in the Cheyenne Mountain in Colorado Springs, CO. It is today our National Command and Control System and it was our Nation's crisis coordination center during 9/11.

Because of my unique experience as a pioneer HF's researcher in Command & Control Systems I was recruited by the Army Research Institute (ARI) to head a unit that they were forming to conduct field research in an operational setting. So I left the USAF to become the head of ARI's human factors research program in Heidelberg, Germany. There I was responsible for the person-computer integration effort associated with the field development of the Army's first mobile computerized Tactical Operations System (TOS). The effort included participation in the largest field test and evaluation of a mobile land warfare automated C&C system that had ever been undertaken – the Seventh Army TOS.

When I returned to the U.S. ARI put me in charge of an interdisciplinary staff of scientists addressing training development problems concerned with the applications of automation, simulation, computer-based instruction (including PLATO and PLANIT systems), and training device technology to improve the combat readiness of active and reserve forces. Subsequently I was given the responsibility for the development of methodologies for developmental and operational field tests to assess the validity of the human factors/human engineering inputs in the acquisition process. In this capacity I was instrumental in the development of the Army's MANPRINT methodology. My final assignment in ARI was to design and develop ARI's corporate information system, i.e., a dedicated computer system to support its strategic and long-range planning; budgeting and operations. Among this system's unique features was the inclusion of a real-time, person-in-the-loop R&D laboratory for doing human factor engineering studies as well as the software and hardware tools for doing artificial intelligence research.

After my government service I went to work in industry where the experience and skills I had acquired in military laboratories provided me with a fresh and sometimes different lens for viewing HF problems in civilian settings. For example, when I found myself heading a team tasked with developing a High School Equivalency Program (HEP) and English as a Second Language (ESL) training program for migrant and seasonal farm workers I realized that computer-assisted instruction provided an answer to the problem. I also served as the project director for the development of a hand-held interactive computer device (compact disc interactive, or CD-I) to assist state and local police in collecting standardized truck accident casualty data. I was also in charge of a contract effort for the U. S. Postal Service (USPS) for the realignment of its field maintenance workforce through job redesign and position consolidation. The latter included a determination of the knowledge's, skills and abilities the new jobs entailed (a sort of civilianized QQPRI). It also included the design, development and implementation of training programs and job performance aids to support these changes. Other civilian applications included the design of a multi-media computer based instruction (CBI) system for the FAA which was focused on the handling of hazardous materials, specifically asbestos and CFCs, during their Air Traffic Control System upgrades. While working in industry I was also responsible for the design and delivery of a training program for the U.S. Office of Personnel Management for implementing telecommuting and flexible workplace arrangements for Federal civilian employees. This latter project was sponsored by the President's Council on Management Improvement.

These, then, are some of the milestones in my career. I would like to say that they were all well thought out and pre-planned but as I look back it was more like a statistical random-walk with a dash of Professor Lotfi Zeda's "fuzzy set theory" thrown in for good measure. But this I can tell you … somewhere in my youth or childhood I must have done something right to have been allowed to have had this much fun later doing what I did.

Employment History (List top 5 positions):

United States Air Force Electronic System Division (AFESD), 1957-1967. *Senior Scientist, Decision Sciences Laboratory*. (Before AFESD the Decision Sciences Laboratory's was part of the Air Force Command and Control Development Division of the AF Cambridge Research Center and the SAGE Operator Research Unit of the Air Forces Personnel and Training Research Center)

United States Army Behavior and Systems Research Laboratory, Heidelberg, Germany, 1967-1970. *Chief, Command System Field Unit*.

United States Army Research Institute, 1970-1984. *Chief, Computers and Communications Technology Office (last ARI assignment, 1982-1984)*.

Allen Corporation of America 1984-1989. *Director, Automation and Research*. (Other industrial organizations after Allen include positions with large industrial organizations like the Singer Company's CAE-Link Corporation; smaller entrepreneurial organizations like the University Research Corporation and Continental Dynamics Incorporated and presently with my own consulting practice Rehill Associates).

University of Maryland – College Park, MD 1984-2009. *Adjunct Faculty* member in the Systems Engineering Department teaching Human Factors and Ergonomics in their Master of Science degree program. (Prior teaching positions include adjunct faculty in the Administrative Science master's degree program at George Washington University where I taught a course in Human Performance and Productivity; adjunct faculty member of the George Washington University's Department of Engineering Management where I taught a graduate level course in Human Engineering; and as a lecturer for the Georgia Institute of Technology in their continuing education course on modeling and simulation.

What were your significant contributions to the field?

<u>Contribution to Human Factors in Command and Control Systems</u>: I was one of the earliest human factors researchers to focus on human/computer system interface problems. There is a certain bit of serendipity in my attaining this distinction because I happened to be at the right place at the right time. I entered the workforce at a time when the first (of the now ubiquitous) interactive digital computer was being born (the AN/FSQ-7). I believe that my colleague, Ira Goldstein, and I may have been the first people to extract a human/computer interface problem from a large scale system development effort; move it into a computerized laboratory setting, and completely automate a research paradigm to answer an operational question. This came about in the early stages of the design of the 425L NORAD system. At that time a question arose about the value of big board displays (i.e., one large display shared by many users) versus individual displays tailored for specific users. We were able to extract the essence of this problem and configure it into a manageable sized laboratory experiment. We fully automated the conduct of the study starting with the instructions to the subjects to directly phasing them into the actual data collection phase followed by the aggregation of the Ss data and subsequent statistical analysis … all on the same system … our automated laboratory PDP-1 computer. It may well have been the first computer-based study published in the HFs Journal. (Baker, J.D. and Goldstein, I. (1966) *Batch vs. sequential displays: Effects on human problem-solving.*

Human Factors, 3, 225 - 235.).

Contribution to Computer-Based Instruction/ Computer-Based Training: I was a pioneer researcher in the domain of computer-based instruction. Again it helped that I had the good fortune to work in one of the few laboratories in the world at a time when few researchers had access to a dedicated research computer like the PDP-1. What started as computer delivered training for SAGE Gap Filler Radar Operators morphed into the teaching of Cuisenaire Math via computer to grade school military dependent's children at Hanscom Field., MA. Later my ARI my research team and I provided high school equivalency training for Army enlisted and civilian personnel through the remote use of the University of Illinois' PLATO System. While at ARI I originated the concept of *Embedded Training* (ET) and implemented it in the TACFIRE system, the Army's artillery command and control system. But my most unique contribution to the area of computer-based training was a technique for acquiring real-time input of subjective probabilities from the student which allowed the computer to determine what it was that the student was uncertain about and to then use that information to make complicated decision as to what next to present to reduce that student's uncertainty. This procedure and my research findings were presented at a NATO meeting in France and subsequently published in a French textbook. (Baker, J.D. The uncertain student and the understanding computer. In F. Bresson & M. Montmollin [Eds.], *La Recherche en Enseignement Programme Tendances Actuell*. Paris: Dunod Press, 1969.)

Contribution to MANPRINT Methodology: In the mid 50's while I was working on the SAGE System myself and others began to realize that concurrent with the multitude of engineering problems that were surfacing was the looming question of what kinds of people, and in what numbers, would it take to operate this "futuristic" system when it was finally fielded. To this human-technology problem mix were the added questions of user-interface requirements and the training that would be needed to operate and maintain SAGE. So my human factors colleagues and I began work on a set of "Personnel Subsystem" guidance documents to address these questions. We borrowed from the tools we were working with at the time, e.g., flow charting for computer programming which we modified to map out what functions the people would be handling and what functions the computer would be handling. We developed a refined technique for breaking down the resultant human functions by developing something new at the time called task analysis. And we then pulled all of this data together into a composite picture of the quantitative and qualitative personnel requirements information document for pre-operational planning purposes. Today you hear this process reduced to an acronym: QQPRI. The USAF latter took all of these tools, plus a few more, and consolidated them into a handbook for program managers. They called it the Personnel Subsystems (PSS) Planning Document.

Fast forward to the 70's. Many of the problems I that I had seen in the Air Force's SAGE system development I saw surfacing again in the Army's TOS. So when I got back to the U.S. I began thinking about what I had learned in my SAGE days and what the implications were for Army automated C&C systems. I presented my thoughts on this topic at a MORS Meeting (Baker, J.D. *Personnel affordability*. Paper presented at the meeting of the Military Operations Research Society 45th Symposium, Fort McNair, VA, July 1978).and some of the pitfalls I cited were subsequently included in Generals Kerwin and Blanchard's "Hollow Army" report to the Chief of Staff of the Army. It was also about this time that the Army got a new, visionary Deputy Chief of Staff for Personnel (DCSPER) – General Max Thurman. He had been the head of the Army's Recruiting Command before taking on the job of the DCSPER so he was sensitive to the "people problems" that he foresaw accompanying the surge of new technology that the Army's planned force modernization program would bring about. Consequently I was involved in a number of

information briefings for General Thurman and my group was subsequently tasked by him to conduct several reverse-engineering studies on recently fielded systems that were not meeting their operational expectations. We were told to determine what user requirements had not been considered at each stage of the system's development cycle and what should have been done at the time to avoid operator problems upon that systems fielding. With this, and considerable other data in hand, General Thurman in the early '80's formalized the Army's procedure for inclusion of human factor requirements throughout the system development cycle. He labeled this system procurement initiative the MANPRINT Program and formalized it in Army Regulation 602-2. In the years since MANPRINT was first initiated it has been expanded and sometimes its focus changed but it has essentially remained true to General Thurman's vision of total inclusion of the requirements of the human-subsystem throughout the system acquisition process. For an overview of MANPRINT program as it is today go to:
http://www.dtic.mil/ndia/2008maneuver/Drillings.pdf

Did you receive any notable awards or recognition during your career?
Awarded Certificate of Recognition signed by Secretary of Defense William Cohen for my Cold War Service to our country as both an Army Infantry Officer and as a government civilian scientist from 2 September 1945 to 26 December 1991

Appointed and served as a Member of the Topic Committee for the *White House Conference on Library and Information Services,* 1991

Originated the concept of *Embedded Training* (ET) and implemented it in the Army's TACFIRE system. Embedded Training entails integrating training packages into operational computerized systems then using the system itself to teach the user how to use the system. For this ET invention I was awarded the U.S. Army's Commanders Medal and Award for Civilian Service, September 1984.

Selected and appointed as U.S. Army Civilian Scientist Participant in the Brookings Institute
Executive Leadership Forum on *Science, Technology, and the Future*, 1982

Appointed and served as Visiting Lecturer for NATO Advanced Study Institute, Mati, Greece, 1976

Elected President, Potomac Chapter Human Factors Society, 1974

Awarded National Psi Chi (National Psychology Honorary Society) Service Award, 1955

Fellow of the Human Factors and Ergonomics Society (HFES); a Fellow of the American Psychological Association (APA); a Fellow of the Association for Psychological Science (APS); and a Senior Member
of the Institute of Electrical and Electronic Engineers (IEEE).

Which articles in the journal *Human Factors* would you say were the most influential to you and your research or practice?
This is a difficult question to answer since over the years there have been so many great HF articles that have influenced my thinking. But because there is a tendency today to ignore any article that has not been written within the past five years so many great articles from the past tend to be ignored or overlooked. So I'll simply pick a few from days

gone bye that had an influence on me and that I feel still have something to say to today's HF's researchers.

For example, any of the many HF's articles by Alphonse Chapanis come to mind. He was particularly interested in safety issues so he conducted some of the earliest research on hospital medication errors due to flaws in the labeling design of prescriptions and doctors' illegible handwriting. But one Chapanis HF article in particular had an influence on me. It was his famous paper entitled, "Words, Words, Words," where he rails against the amazing number of situations, from highways to elevators, in which confusing and even conflicting wording of signs contributed to errors having safety implications. Chapanis, A. (1965). *Words, words, words*. Human Factors, *7*, 1-17.

Another paper that shaped the way I dealt with human factors problems in the "real world" was the paper by Dave Meister wherein he discussed the "translation problem" one encounters in getting across our HF research findings and their implications for system designers and engineers. It is worth reading if you are going to be doing any work in a systems engineering environment. It is Meister, D. and Farr, D. (1967) *The utilization of human factors information by designers.* Human Factors, 9, 71-87.

And I must include an article that describes a technique for studying dynamic human information processing in a systems setting; what today we tend to call situation awareness. It is the work done by Dowe Yntema which is described in one particular HF article. I have used his technique (i.e., his model) in several studies and I have found it eminently transferable and useful with only minor tweaking. Yntema, D.B., (1963) *Keeping track of several things at once*, Human Factors, 5, 7-17.

Please provide any links to your online articles, essays, blogs, Wikipedia pages, etc., that pertain to your research, publications or practice.

I thought this might be an appropriate place to include my latest research interest: The "graying" of America and its implications for human factors research. The United States is growing older. Using the arbitrary age of 65 as the demarcation line into "old age" the portion of the population that is currently at least 65 years old—13 percent—is expected to reach about 20 percent by 2050, i.e., one in five Americans will be "older citizens." Add to this the projection that more and more older people will be remaining in the workplace and that has implications for workplace design. So this "graying of America" has convinced me that a considerable amount of future HF research will be addressing the benefits of technology that can be utilized by older adults to support and enhance their independence, productivity, health, safety, social connectedness and quality of life.

Related to this changing demographic trend, I presently serve as a member of the External Scientific Advisory Board for the Center for Research and Education on Aging and Technology Enhancement (CREATE). CREATE is a large federally sponsored program funded by the National Institute of Health's National Institute on Aging. It consists of a consortium of research centers, which includes The University of Miami, Georgia Institute of Technology, and Florida State University, all under the direction of the University of Miami. The CREATE research program is investigating how aging influences technology use, which technology interfaces work best for older adults, and what techniques work best to instruct older adults in technology use. Examination of the work currently being conducted by the CREATE research team would be a good starting place for anyone interested in this area of HF research. To see a listing of the CREATE research reports currently available on this topics go to:

http://www.psychology.gatech.edu/create/index.php

What advice would you give someone considering HF/E as a profession?
These three things: Find your passion; add as many HF/E arrows to your quiver as possible, and begin to think like a futurist.

Find Your Passion: If HF/E is really what you want to do in life then get a good education. After that the best place to begin to plug-in is through "old boy/old girl networks." Sit down with faculty members whom you respect and ask them where they would suggest you begin to look for opportunities as a fledgling HF/E professional. Go to HF/E's and other related conferences and talk to the folks there. Spend some time talking with your peers who may be now working in the field and ask them for their pros and cons about the track they are now on and what things they considered in making their decision to follow HF/E as a profession. Then, if you feel this is for you, give it your best shot.

Later if the career track you are following starts to look boring – look for something different to do. Change tracks, change jobs, change venues. Then, with luck, what you are engaged-in will reach a point where it is a pleasure each day to do what you are doing. Then you will have reached that place deep inside you where passion lies … and you will find that nothing you attempt to do thereafter is impossible and you'll be looking forward to the start of each new day. And finally, don't let yourself get boxed-in. If later in life if you discover a new passion … give it a try. Follow the example of a long time friend of mine – a giant in our HF/E profession -- named Dave Meister. Late in life he became deeply enamored with American History and at age 65 went back to school and got a Master's Degree in the subject. There was man who was really passionate about life.

Add as Many Arrows to Your Quiver as You Can: While most people coming into our profession started as psychology majors today more and more disciplines are now represented in our profession. Systems engineers, computer science majors and a host of other disciplines are there to be found. But the one keystone … the one essential bit of training that I have found necessary for dealing with every HF/E problem that I have encountered … is to be well schooled in the tenets of the Scientific Method. It is the foundation for everything we do whether in the laboratory or in the field. If you would like to brush up on these tenets you may want to look at an article that walks through the Scientific Method and describes, during the walkthrough, how laboratory and field tests differ in its application (see: Johnson, E.M. & Baker, J.D. (1974) *Field testing: The delicate compromise*. Human Factors, 16(3), 203-214).

But in time, and as you do battle with the myriad of problems that you will encounter across a broad spectrum of HF/E applications, the more additional tools (arrows) you add to your quiver the better off you will be. If you have taken solid HF/E courses and strengthened them with courses in a variety of statistical techniques as well as having gained familiarity with a host of applicable software packages you will be off to a good start. But there are additional engineering tools (e.g., fault tree analysis, link analysis, etc.) that you should know about if you are practicing outside of an academic laboratory environment. They are part of the "engineer-speak" in most system design and development meetings. One good place to find a listing of these tools, and how they are employed by HF/E types in operational settings, is in Chapter 4 of Chapanis, A. *Human Factors in Systems Engineering*, (1996) John Wiley Sons, Inc. New York, NY.

Think Like a Futurist: Don't get bogged down in addressing only the problems that HFs is interested in today or you may find yourself panning for small nuggets while the motherlode remains untouched. For example, while I had the good fortune to have been involved in the earliest days of the development of digital computers who would have thought at the time (some fifty+ years ago) that the “large beasts” we were concerned with then would one day morph into the small, portable hand-held ubiquitous devices that we take for granted today. And who could have foreseen that the interactive network of digital devices that then made up the nationwide interconnected SAGE system we were working on might one day morph into something we would call the ARPNET and subsequently into what we know today as that worldwide network of computer nodes called the Internet. So my advice to someone just entering the HFs profession today is to devote some time to thinking like a futurist if you really want to have an impact on our profession.

What does that mean? Well a few years ago I wanted to know what futurists did and, further, what they were predicting that might affect HFs and Ergonomics professionals as we approached the turn of this Century. So I attended one of their World Future Society’s Annual Meetings. What I concluded from that experience is summarized in Baker, J. D. *Creating the 21st Century*, Ergonomics and Design, June, 1994. But in essence what it says is that the world of HFs problems that will be challenging today’s fledgling HF practitioners several decades from now should begin to be examined today. It is a cliché to say it but try to think out of the box – try to peer over the horizon. For example, you and your colleagues will be living in an aging society and with that demographic change will come a host of people-device HFs issues and questions needing answers. Now is the time to consider them. Why now instead of later? I think the answer to that question was best summed up by Joel Barker:

“Most people know the future only as a place that is always robbing them of their security, breaking promises, changing the rules on them, causing all sorts of troubles. And yet it is in the future where our greatest leverage is. We can’t change the past, although if we were smart we could learn from it. Things happen in only one place – the present—and usually we [can only] *react to those events. The ‘space’ of time in the present is too slim to allow for much more. It is in the yet-to-be, the future, and only there, where we can have time to prepare for the* [soon to be] *present.”* - **Barker, J.A. (1992) Future edge: Discovering the new paradigm of success. New York: William Morrow.**