

Ergonomics for Children: Forward Directions

Panelists:

Valerie Rice, General Ergonomics, Selma, TX
Hal Hendrick, Hendrick & Associates, Castle Rock, CO
Karen Jacobs, Boston University, Boston, MA
Rani Lueder, Humanics ErgoSystems, Encino, CA
Jake Pauls, Jake Pauls Consulting Services, Silver Spring, MD
Michael Wogalter, North Carolina State University, Raleigh, NC

Panel Organizer:

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ABSTRACT

A relatively new area of human factors/ergonomics practice focuses on designing for children. The objective of this panel is to discuss 'forward directions' for human factors professionals currently designing for children or desiring to begin working with design of environments, goods, and procedures for children. Each panelist is an expert in an aspect of design that applies to children. Each will give a brief example of their practice or experience. They will offer their opinion on the greatest issues facing human factors engineers as they investigate design for children and the challenges facing the world's children of today.

OVERVIEW

It has not been that long since the definition of 'work' in Human Factor/Ergonomics appeared to refer almost solely to either activities in ones' place of employment or the expenditure of physical energy during labor. Only 15 years ago, professors in the field publicly stated there was no place for addressing 'special' populations within human factors, as all human factors design applied to the 5th to 95th percentile of the population. Of course, not all human factors engineers believed this, but the sentiment was pervasive.

In recent years, we have seen a growth of interest in applying human factors principles to designing for special populations including those who must function with permanent or long-term illnesses or disabilities (or conditions such as pregnancy), elderly populations, and children.

Early human factors focused on industrial work places and military applications, but even this has changed over time. Growth in the field has expanded to places outside these areas and outside one's place of employment to include 'settings' as surface transportation, health care, internet, and virtual environments. Like some other professions, the definition of 'work' has seemingly been redefined, as human factors engineers study humans singly and collectively and use that information to design products (including technologies), systems, methods, and environments.

One of the most exciting new, targeted populations is children. Their 'work' is to learn and expand their skills and abilities cognitively, emotionally, socially, culturally, and physically. They do this in their homes, on playgrounds, in schools, and in public and private spaces. While so much design has been

done for children, little has been designed according to their abilities, limitations, and growth and development patterns. How often have we heard 'children are resilient' meaning 'children are flexible, adaptable; they'll do fine', but will they? Will sitting on a straight-backed chair at a table that is too high or too low for them not influence their physical growth? Will they rebound to become happy, functional adults after unhappy

early social interactions, abuse, lack of physical and emotional stimulation, dysfunctional or non-existing families?

It seems our society, including those of us who are human factors engineers, 'speak out of both sides of our mouth'. That is, we know these things influence our children's development and often their functioning as adults, yet sufficient attention has not been given to what we commonly refer to as our "greatest treasure" and "our future": our children.

The practice of human factors as applied to environments, products, and processes that involve children is relatively new.

Therefore providing the participating audience with some facts, issues, and future directions will move research and interventions forward at an accelerated pace.

PANELISTS

A bio-sketch for each panelist and his or her abstract (addressing the questions in the objections), follows:

Valerie Rice

1) Valerie J. Berg Rice, PhD, CPE, OTR/L, FAOTA has graduate degrees in industrial engineering and operations research (human factors/ergonomics option), occupational therapy, and health care administration. She is a board-certified ergonomist, a registered and licensed occupational therapist and a fellow of the American Occupational Therapy Association (AOTA). She has helped children and their parents address design issues in their homes schools, and programs of learning, as well having provided patient treatment to children with developmental, physical, and cognitive injuries and illnesses. She has presented and published extensively on human factors as applied to cognition, education and training (learning, attention deficit disorder, stress), industrial applications (injury prevention, safety, and physically demanding tasks), user evaluations, and macroergonomics. She edited the text, *Ergonomics in Health Care and Rehabilitation* and co-edited *"Ergonomics for children: Designing products and places for toddlers to teens"* (2008, Taylor & Francis). Dr. Rice completed 25 years of active duty service in the US Army and has worked for Army Research Laboratory for 5 years. She served on the Board of Directors for the Human Factors and Ergonomics Society (HFES) and the Board of Certification in Professional Ergonomics (BCPE) and is currently the President of the Board of Directors for the Foundation for Professional Ergonomics (FPE). Her website at www.genergo.com provides additional background on her ergonomics consulting services and related ergonomics activities related to children.

2) Greatest Issues Facing HF Engineers as They Investigate Issues or Designs for Children:

The biggest issues for human factors engineers will be learning about their user populations, designing to both match current skills and pull children into appropriate developmental growth, and creating designs that are usable by a variety of abilities and ages – including those with disabilities. Users include children, their parents and relatives, caregivers, and teachers/instructors. These populations are not covered during typical human factors educational curriculums. Child development is also not usually covered during human factors educational programs, including changes that occur during growth and development- physical, cognitive, social and emotional. Human Factors professionals will have to learn this on their own or pair with another professional who has this knowledge (along with the skills to work with children). This knowledge must be applied to design in a way that is unique for children (not used with adults) and that means designing to match the capabilities and limitations of some children, while concurrently “pulling” them into continued development of new skills – not an easy task! The final

challenges are getting society and manufacturers to listen and design according to children's needs rather than designing according to adult's convenience.

3) Identify their judgment as to the greatest issues facing the world's children of today:

On a worldwide scale, the greatest threats for children are poverty, nutrition, and environmental contamination. According to the World Health Organization, while children under age 5 comprise 10% of the world's population, over 40% of the burden of environmentally related disease falls on them – and they are particularly vulnerable during their rapid growth and development. Another concern involves work related injuries in developing countries. While these issues often exist in developed countries, few human factors professionals (in developed countries) working with children's issues, tend to be working in the following areas. Areas include designing products, such as toys and playgrounds, expert witnessing in cases of injuries, and accidents, design of children's workstations and interactions with computers, and in child safety, all of which can influence children's future growth, development and performance.

Hal Hendrick

1) Hal Hendrick, PhD, CPE is Emeritus Professor of Human Factors and Ergonomics at the University of Southern California and Principal of Hendrick and Associates, a private consulting firm. Previously, he was Executive Director of USC's Institute of Safety and Systems Management and had chaired the University's Human Factors Department. Hal is a Past President of the Human Factors and Ergonomics Society (HFES), the International Ergonomics Association (IEA) and the Board of Certification in Professional Ergonomics (BCPE). He is a Fellow of the IEA, HFES, American Psychological Association and American Psychological Society. He has authored over 200 professional publications, including three books and edited ten books. He has served as an expert witness in numerous unintentional shooting cases and writes extensively about human factors of handgun training and design. He is a Certified Professional Ergonomist and holds a PhD in Industrial Psychology and MS in Human Factors from Purdue University.

Additional Background on Dr. Hendricks work with children:

Dr. Hendrick states: In terms of ergonomics, personal involvement, mine has been with the issues of handguns and child safety, which I recently discussed in two books. The first being Rani Lueder and Valerie Rice's book on ergonomics and children; the second is my own co-authored book on “Human Factors Issues in Handgun Safety and Forensics. Wearing my Psychology Hat, I have been involved in the study of Cognitive Complexity, Conceptual Systems and Behavior as affected by childrearing patterns. I have a number of refereed journal articles and book chapters in this area.

2) Greatest Issues Facing HF Engineers as They Investigate Issues or Designs for Children:

Foremost we need to address the issues of the design of computer workstations and other objects with which children interact with. In part, this also involves the issue of parental

awareness. For example, research has shown that parents overestimate the ability of children to recognize the dangers of handling a handgun and the need to secure handguns in the home. I also believe from my interactions with parents that they do not recognize the importance of designing home computer workstations to fit children.

3) Identify their judgment as to the greatest issues facing the world's children of today:

At the worldwide level, I believe, in terms of ergonomics, that it is the exposure of children to unhealthy work environments where they work – particularly in Industrially Developing Countries. As Kogi and others have demonstrated (including myself in the Philippines), simple, inexpensive, ergonomic solutions can go a long way to improve these working conditions. Of course, protection from disease, contaminated water, etc. is probably the single greatest issue – again, especially in IDC's.

Karen Jacobs

1) Karen Jacobs, Ed.D. OTR/L, CPE, FAOTA is a past president and vice president of the American Occupational Therapy Association (AOTA). She is a 2005 recipient of a Fulbright Scholarship to the University of Akureyri in Akureyri, Iceland. Dr. Jacobs is a Clinical Professor and the Program Director of Distance Education Post-professional Programs in Occupational Therapy at Boston University, where she has worked since 1983. Dr. Jacobs is an occupational therapist, a board certified professional ergonomist and the founding editor of the international interdisciplinary journal *WORK: A Journal of Prevention, Assessment and Rehabilitation*. She is the chairperson of the International Ergonomics Association's (IEA) Ergonomics for Children and Educational Environments Committee (ECEE), <http://www.iea.cc/ergonomics4children/index.html> and (ECEE) Technical Committee.

She earned her Ed.D at the University of Massachusetts Lowell, her MS at Boston University and her BA at Washington University in St. Louis, Missouri.

Additional Background Information on Dr. Jacobs work with children:

Dr. Jacobs' research examines the interface between the environment and human capabilities. In particular, she examines the individual factors and environmental demands associated with increased risk of functional limitations among populations of university and middle school aged students, particularly in notebook computing and backpack use <http://people.bu.edu/kjacobs>. Dr. Jacobs designs "healthy home" programs that address health, wellness, and injury prevention in relationship to computer and backpack use.

2) Greatest Issues Facing HF Engineers as They Investigate Issues or Designs for Children:

In my opinion, an overarching issue is what impact information technology is having on a child's healthy development. Another issue is the mismatch between the child and the environment, tools and equipment they use. One-size-fits-all really does not work. For example, in many US schools, furniture such as chairs, desks, and computer workstation typically do not fit a child's anthropometric

measurements; and does not encourage active use of postural muscles. The lack of financial resources as well as awareness by those who purchase furniture for the school is a significant factor.

3) Identify their judgment as to the greatest issues facing the world's children of today:

In my judgment, the greatest issues facing children of the world today is the lack of physical activity, proper nutrition, obesity, tobacco use, and the impact of environmental tobacco smoke on children. There is a need to design effective wellness programs that address these concerns. For example, in the US schools, there is little time allotted for recess or physical education. Many schools have removed equipment completely from school grounds secondary to the influx of unnecessary law suits. Our children are not playing on a daily basis in a physical way and that impacts their overall well-being and development

Rani Lueder

Ergonomics for children...

What do we know that is plain wrong?

It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.

Mark Twain

1) Rani Lueder, MSIE, CPE is President of *Humanics ErgoSystems, Inc.* an ergonomics consulting firm in Encino, California she established in 1982. She has consulted and served as an expert witness in occupational ergonomics and the design and evaluation of products and places for adults, children and people with disabilities for over 25 years. She also teaches human factors and ergonomics in industrial design at *Art Center College of Design in Pasadena*. She recently co-edited and co-authored "*Ergonomics for children: Designing products and places for toddlers to teens*" (2008, Taylor & Francis). She also co-edited "*Hard Facts about Soft Machines: The ergonomics of seated posture*" (1995, Taylor & Francis) and "*The Ergonomics Payoff; Designing the electronic office*" (HRW).

Rani has an MSIE in Ergonomics/Industrial Engineering from Virginia Tech. Her website www.humanics-es.com contains extensive content on ergonomics and ergonomics for children.

2) Only in recent times have ergonomists been commonly asked to evaluate products for children. In my early years as a consultant, infrequently I been asked to help design safety products such as bicycle helmet design for children – but manufacturers were much less likely to seek ergonomics assistance with other child products.

In part, the lack of clear research directions related to the multi-dimensional nature of the research. **All cultures are very concerned about their children's health, safety and development.** Yet research about products for children resides in many databases: medical, optometry, product / industrial design, education, urban design, architecture, human engineering, law and others.

Of course, children do not only use products for children; they also interact with products intended for other users such as

adults. Consumer products must routinely consider the potential impact of product features on unintended child users. For example, I am now participating as an expert witness on a case where a child was seriously harmed because the manufacturer ignored the first principle in ergonomics – *do no harm to all your possible users of a product*.

Traditionally, government agencies were responsible for the child ergonomics research. The *Consumer Product Safety Commission* (CPSC) tracks product related injuries; when it detects hazardous products or product features, it tries to step in to “strong-arm” a manufacturer or enact legislation to reduce the rates of product injuries. The *Centers for Disease Control* (CDC) provides important guidance on child development and health. The *National Institute for Occupational Safety and Health* (NIOSH) continues to study how to prevent injuries in adolescent workers. The *Department of Transportation* (DOT) performed important critical efforts that for example led to improved safety car seats for children, and car designs to accommodate them. International efforts that promote ergonomics for children include the *World Health Organization* (WHO), *United Nations*, and various government agencies in other countries.

Today, we increasingly recognize the importance of considering the physical, sensory and cognitive developmental stages that children of different ages undergo and its implications for designing healthful products and environments for children in different cultures and nations. Not only do children differ from adults, their needs at different stages differ and often conflict.

We made great strides in our understanding of how to design products and places for children – and where they are at risk. Researchers and practitioners also lose their way in a quagmire of misplaced assumptions that steer us in wrong directions.

Jake Pauls

1) Jake Pauls, CPE is a certified professional ergonomist. He has 41 years of international experience in research, codes and standards development, public health advocacy and consulting. His subject matter expertise is in ergonomics, architectural and engineering aspects of movement of people, individually and in crowds, especially on stairways. Of course, this includes children and their movement. He currently serves on 12 national standards and codes committees in the U.S., where he is known for bridging among ergonomics, public health, and the development of codes and standards for building usability, safety, design, construction, and management.

Additional background on Jake Pauls work with children: Children and Pedestrian Circulation Facilities. Perspectives of Jake Pauls, CPE from field studies of large public assembly facilities, safety standards development, and work in public health over a 41-year career.

Jake Pauls states: In my early research years, I devoted much effort to observing and documenting the movement of people at large public events, especially in relation to particularly demanding facilities such as stairways. Children of all ages

were always present at such events and, more so than other people, appeared to find special delight in playing on stairs and with railings. Watching children using handrails of various heights and playing with them as well with guardrails provided valuable insights into how such architectural features could be designed and constructed more functionally to serve all their users. For example, handrails should be higher—for all ambulatory users—than was traditionally recommended or mandated for design. These field-based insights were supported by work by others involving experimentation with children using all kinds of pedestrian facilities in Australia.

2) Issues Facing HF Engineers as They Investigate Issues or Designs for Children: Ethical issues are posed; both in observing children’s behavior in field settings and in having them serve as subjects with mocked-up facilities. Some of the most publicized insights into children are climbing behavior with guard rails come from situations that should not exist. Ethical issues are also raised in arguments by some that we need not improve the design of such railings, or retrofit existing ones; the problem in their view is inadequate supervision of the children. It is a variation on the old “Blame the victim” rationalization.

3) Identify their judgment as to the greatest issues facing the world’s children of today: The greatest issue facing children of the world today is the narrowing of their worlds, in terms of physical activity in a variety of natural settings. Reduced fitness and increases in obesity, along with the secondary and tertiary health consequences, are growing problems of epidemic proportions. Solving these problems will require broad application of ergonomics and many other fields of knowledge, including public health; the challenges of prevention and mitigation are daunting. For one thing, one of the most defining of human activities, bipedal movement ability is being degraded.

Mike Wogalter

1) Michael S. Wogalter, PhD is a Professor of Psychology at North Carolina State University, and is a faculty member in the Human Factors and Ergonomics graduate program and Cognitive Ergonomics Laboratory in the Psychology Department. Prior to arriving NC State in 1992, he held faculty appointments at the University of Richmond (1986-1989) and Rensselaer Polytechnic Institute (1989-1992). He received a B.A. in Psychology from the University of Virginia (1978), an M.A. in Human Experimental Psychology from the University of South Florida (1982), and a PhD in Human Factors Psychology from Rice University (1986). Most of his research focuses on issues associated with warning effectiveness and hazard perceptions, with a large proportion of his 300 plus publications on this topic. He is on the editorial boards of several scholarly scientific journals including *Applied Ergonomics*, *Journal of Safety Research* and *Theoretical Issues in Ergonomics Science*. He has held a number of offices and roles in the Human Factors and Ergonomics Society (HFES) such as Chair and Program Chair of both the Safety Technical and the Forensic Professional Groups, and Secretary-Treasurer, and Executive Council member. He is a Fellow of HFES and the International

Ergonomics Association. He consults in various legal cases across the U.S. as an expert witness concerning issues associated with human factors/ergonomics, hazard perception, communication-human information processing, and warnings.

Additional information on Dr. Wogalter's work with

children. Dr. Wogalter states that some of his consulting work involves litigation in which a child has gotten hurt and I am asked, whether the warnings, if any were present, conveyed adequate information about the hazard that caused harm to the child. Most of the time, product and environmental warnings are intended for caretaker adults, *not* children. We know that children, from infants and teens, have a wide range in perceptual, cognitive and motor capabilities. In some cases, particularly with older children maturation enables conveyance of warnings directly to children.

2) HF/E Issues in the investigation of designs for children:

In my contribution to the panel, I will introduce warning issues relevant for children. First, I will explain about why the subject is important. Older children can usually read and may be able to decipher symbols as well or better than adults can. It makes sense to communicate hazards to individuals who have cognitive abilities. For example, current airbag warnings say that children 12 and under should not sit in the front seat. Very young children cannot read this warning, although older children will be able to read it.

Communicating the message to children 12 and under would assist or support the caretaker's admonitions that the child must sit in the back. In addition, the older child through reading a warning could potentially enhance the safety of the younger child.

Age, is of course not entirely predictive of ability to read or understand warnings, but age can provide some guidance. How low of an age one can go in terms of communicating warnings is unclear and probably depends on the message and method of communicating it. Use of symbols and colors may assist communication. Automated voice warnings may also be beneficial. Some headway on this topic is groundbreaking.

Some researchers have suggested that warnings may produce a "boomerang" effect in older children (particularly males). The boomerang is that communicating hazard produces an unintended consequence by inviting or attracting children to a hazard. The so-called "effects", probably should be considered, although they should not outweigh the preponderance of evidence indicating safety enhancements are more likely to produce benefit than harm.