Experimental Aging Research, 28: 99–110, 2002

0361-073X/02 $12.00+.00

Prioritizing Ergonomic Research in Aging for the 21st Century American Workforce

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The Bureau of Labor Statistics predicts that by 2008 Americans aged 55 and over will represent the greatest annual growth rate and will occupy 30% of the American population. Additionally, by 2008 civilian labor force participation rates for the 55 and older group will grow to 36.8%, a 6.5% increase over the participation rates for this group for 1996, with the 55 to 64 age group expected to add 7.3 million workers. The predicted median age of the labor force for 2008 is estimated at 40.7 years, an age not approached because the median age peaked at 40.5 years in 1962. Coupled with this aging profile, employment in professional specialty occupations will increase the fastest and add the most jobs in the decade leading to 2008. Within the professional specialty professions, the majority of the employment increases are expected to occur in the service industry division. The purpose of this paper is to merge demographic data with ergonomic and human factors data and predictions to explore areas of ergonomic research that will aid in keeping the aging workforce, and those with whom they interact, healthy in their jobs and keep the companies for whom they are employed competitive. Although some ergonomics research has been conducted in all the listed areas of expected growth, the paper reexamines the job demands in each sector, with a focus on the needs of the aging workforce.

Received 25 July 2001; accepted 18 August 2001.
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As we enter into the 21st century, demographic changes in the age and composition of the labor force coupled with an expanding economy and a declining birth rate will necessitate older employees remaining in the labor force. By 2008, the Bureau of Labor Statistics predicts that Americans aged 55 and over will represent 30% of the population and the labor force participation for this group will grow to 36.8% (Fullerton, 1999). This increase in the older population will also be accompanied by a growth in the youth labor force (aged 16 to 24 years). In addition to this explosion of older Americans, the postmodern American economy is becoming postindustrial and service oriented. This change is leading to great growth rates in the professional specialty occupations coupled with large numerical growth in service occupations, creating a bifurcation with many new jobs existing in either the highest or lowest paid job sectors (Braddock, 1999).

In order to keep the workforce healthy and maximize their efforts, ergonomists must look to both the changes in demographics and the growing sectors of the economy (Wegman, 1999). Increasingly, many of the manufacturing jobs will be replaced by professional specialty occupations or technical and related support positions. These newly added jobs may be in offices, warehouses, hospitals, or financial institutions. Changes in work location will give rise to new ergonomic challenges in the form of different physical work environments, varied interaction with the public, increased demands for efficiency, and the ubiquitous 24–7 work schedule. Increasingly, we will see older women and minorities added to the labor force because of financial or demographic reasons. In addition, the workforce will also experience movement towards flexible scheduling and work location (Department of Labor, 1999).

GROWING SECTORS OF THE AMERICAN ECONOMY

We live in an expanding economy where total employment is projected to increase by 20.3 million jobs over the 1998–2008 period (Braddock, 1999). Within these created jobs, growth rates on average are projected to be greatest for occupations requiring at least an associate degree, even though many jobs that require only short-term on-the-job training will also contribute to the numerical increases in positions.

Among the major occupational groups, employment in the professional specialty occupations will increase the fastest and add the most jobs from 1998 to 2008 (Braddock, 1999). These increases represent a 27.0% increase, equaling some 5,343,000 new jobs in these areas. Within the professional specialty occupations, engineers, computer professionals, teachers, and health assessment and treating occupations are expected to add the greatest percentages of jobs. Specifically, systems analysts are expected to increase by 577,000 jobs, while it is predicted that 451,000 registered nurses will be added to the labor force (Braddock, 1999).

The group with the second fastest growth rate is technicians and related supported occupations. It is expected that this group will experience a 22.2% increase in the number of jobs and thus add approximately 1,098,000 jobs in this sector (Braddock, 1999). Within this area, nearly half of the increase for jobs for technicians will be in the health services industry, while engineering science technicians are expected to also see great additions to their ranks.

The third fastest growing sector is service occupations, with expected jobs predicted to increase by 17.1% (Braddock, 1999). More than half of the 4 million additional service jobs will occur in business services, health services, and social services. For example, retail salespersons and cashiers are expected to add over 1.1 million jobs, food preparation and service occupations are expected to add another 1.1 million jobs, and personal service occupations are expected to increase by 894,000 jobs. The precision production, craft, and repair occupations are expected to increase by nearly 1.3 million jobs from 1998 to 2008 (Braddock, 1999). Although manufacturing is expected to experience a loss in jobs, this will be offset by increases in the service industry, especially in temporary services. The construction trades are expected to add some 390,000 jobs by 2008, an addition largely guided by the increase in need for housing.

Of special interest is the rapidly growing sector associated with the internet and e-commerce. Estimates for internet use for the year 2000 are expected at 133 million users. E-commerce represents a change in retailing, a reduction in the use of conventional stores, an increase in mail delivery services, and increased warehouse activity. From 1996 to 1997, sales through e-commerce more than doubled from $15.5 to $38.8 billion. New estimates are for total e-commerce to reach $1 trillion a year by 2005 (Organization for Economic Cooperation and Development, 1999).

CHANGES IN WORK ARRANGEMENT

Work arrangements and schedules are changing and moving along with the 24-hour 7-day economy. No longer do most employees work the same day shift Monday through Friday, but as of 1997 only 29.1% of employed U.S. citizens worked a "standard work week," 35 to 40 hours a week, Monday through Friday (Presser, 1999). Only 54.4% regularly work a fixed daytime schedule for any number of hours. In addition, 40% of all employed Americans work mostly during the evenings or nights, on rotating shifts, or on weekends (Presser, 1999).

Not only has the time that Americans work changed, but work arrangements, such as full-time/part-time issues, year-round work, scheduling, and workplace location, have changed. These changes have largely been spurred by three things: the changing economy, changing demography, and changing technology (Presser, 1999). The growth of the service sector over the manufacturing sector has led to the explosion of businesses that run 24–7.

These businesses may be found in retail, financial services, or in health care. In many cases the changing demography has led to more health care services for the older population. In addition, the increase in the number of working women has created the need for services that are open at night, on weekends, or 24 hours a day. The ubiquity of computers and technology and the need for multinational businesses to be opened at the same time has also led to many 24–7 companies (Presser, 1999).

Although the percentage of workers who work full-time has remained nearly constant since the early 1970s, there is an increasing trend towards year-round work over seasonal employment. This trend towards year-round work is thought to be the result of the increased likelihood of women working year-round (Department of Labor, 1999). Data also suggest that working women may be disproportionately employed in service occupations that have nonstandard working hours (Presser, 1999). Many of these occupations, such as cashiers, registered nurses, and salespersons are also expected to experience the largest growth during the next decade, thus creating a greater percentage of employees who would be employed during nonstandard working hours. It may be that the entire concept of "standard working hours" becomes obsolete during the next few decades.

Although still just representing a small fraction of the work arrangements, there is a trend towards the increased use of flexitime and flexiplace. Flexiplace arrangements allow the employee to work at home, often with the benefit of easing child or family care challenges. In addition, flexiplace arrangements may also help with the employment of many rural workers who do not live close enough to various companies to commute daily. In 1995, at least 32 million Americans telecommuted to work, and this number is expected to increase by 20% per year (Czaja, 1999). Most of these workers use the internet, e-mail, fax machines, and cellular phones to adequately perform their functions from their home. The Department of Labor also predicts that job-sharing and flexible schedules will become more prevalent (Department of Labor, 1999).

Assistive technologies, such as character readers and voice recognition devices, will open up the workplace to individuals with disabilities. In addition, better transportation systems and home design will allow individuals to live and work independently. These individuals may commute to work or they may choose to telecommute.

CHANGES IN THE LABOR FORCE

The labor force is expected to reach 155 million by the year 2008 (Fullerton, 1999). The rate of growth of women in the labor force will increase at a faster rate than of men, and therefore the proportion of women in the labor force will grow to 48% in 2008. This labor force is significantly affected by the baby-boom cohort that was born between the years 1946 and

1964 and thus will begin to reach age 65 in the year 2011. The predicted median age of the labor force for 2008 is estimated at 40.7 years, an increase over both the median age for 1998 (38.7 years) and 1988 (35.9 years). At the same time, the predicted median age for the population for 2008 is estimated at 44.6 years, again an increase over the estimates for 1998 (41.9 years) and 1988 (39.4 years). These statistics indicate that by 2008 Americans aged 55 and older will represent 30% of the population. For this 55 year and older group in 2008, labor force participation rates will grow to 36.8%, a 6.5% increase over the participation rates for this group in 1996 (Fullerton, 1999).

Additionally, the percent participation by age will be different between men and women. For the last three decades of the twentieth century, the male labor force has been older than the female labor force. However, as we enter the 21st century, the ages of male and female labor force are projected to diverge. The labor force participation rates for women 55 years and older are expected to increase by 6.2% between 1998 to 2008 to 31.2%. At the same time, the labor force participation rates for men of the same age are expected to increase by only 4.4% to 43.5%. Both sets of information represent increases for the participation rates for this age group across the last twenty years. These changes will continue to be reflected in the higher participation of older women, the slowing of participation of younger women, and the withdrawal of older men from the labor force (Fullerton, 1997).

Another change in the demography is the growth of the youth labor force aged 16 to 24 years. During the period from 1998 to 2008, this cohort is expected to grow more rapidly than the overall labor force for the first time in 25 years (Fullerton, 1999). These implications are interesting for ergonomics as many younger and older workers will be occupied in the same type of service occupations that require only short-term on-the-job training.

Finally, the racial composition of the United States is changing as minorities continue to increase in proportion and their labor force rates continue to increase. For instance, for the years 1998 to 2008, Hispanics are expected to increase their share of the labor force from 10.4% to 12.7%, African Americans are expected to increase from 11.6% to 12.4%, and Asians are expected to increase from 4.6% to 5.7%. Because the Hispanic population will grow faster than the African American population, the Hispanic labor force is estimated to be larger than the black labor force by 2008. Additionally, although the Asian population is growing rapidly, it is still predicted to remain the smallest of the labor force groups well beyond 2008 (Fullerton, 1999).

IMPLICATIONS FOR ERGONOMICS

Future changes in growth of certain occupational sectors coupled with the increase in the median worker age and the increased labor participation later in life provide challenges to the ergonomist. More research should be directed

towards these issues now while the baby boom cohort is just beginning to experience the cognitive, musculoskeletal, and aerobic declines associated with aging that begin in the fourth and fifth decade of life. The goals of our research and our applied work should not be to change the older adult into the young adult, but rather to improve the environment/job so that the older adult can function sufficiently and remain productive as long as he/she desires (Craik & Salthouse, 1992). In addition, although some ergonomic improvements may improve working conditions for old and young alike, researchers should be especially concerned where research leads them to interactions between age and working condition, a situation that could lead to targeted interventions.

Anthropometry

With aging comes the inevitable reduction in stature that affects both the male and the female population (Kelly & Kroemer, 1990). In addition, the stature differences that are evident among different racial groups have the ability in some cases to eclipse age and gender differences (Jurgens, Aune, & Pieper, 1990). Such changes in stature have the ability to affect workplace performance, whether the employee is located in a computer-based position or in a physically demanding job. For instance, the anticipated growth in the professional specialty occupations, technicians, and the service industry all have in common their dependence upon the computer. However, recent articles have pointed to the lack of anthropometric data on the older population and the subsequent consequences for work station design (Annis, 1996). Changes in height may make some workstations uncomfortable and even dangerous for the older worker. In addition, workstations need to be designed for both men and women, so that sight and reach parameters meet the requirements of the majority of the population. A recent article on the relationship between age, stature, and gender in a biomechanical modeling study of driving behavior demonstrated that older persons move differently when they reach for components inside the compartment of a car (Chaffin, Faraway, Zhang, & Woolley, 2000). In this study, the older persons kept their elbows closer to their torsos than did the younger persons in the various reaching activities. These types of studies provide valuable information that will help designers in their efforts to produce usable products for all ages of the population.

Another good approach might be to follow the design of Clark, Czaja, and Weber (1990) in their study on older adults and daily living task profiles. In their study, the researchers performed task analysis on 25 activities of daily living (ADLs) tasks to determine what types of demands were made on the older adults. Through their study they determined the percentage of time that people spent in certain postures (e.g., bending motions) and the various reaches for certain tasks. By comparing these data with anthropometric guidelines, the researcher would be able to target certain areas for re-design.

Cognitive Performance

Changes that accompany aging often include decreases in reaction times, difficulty with fluid intelligence tasks, and decreases in the capacity of working memory to process certain kinds of declarative information and to access it in long-term memory (Papalia, Camp, & Feldman, 1996). However, with advancing age, increases in expertise and the ability to call on general knowledge to solve everyday problems also occur. Inferences are especially difficult to make from the cognitive research because slowing of information processing speed has not been correlated with decreases in on-the-job performance.

For instance, the slowing of information-processing speed may impact human computer interaction (Sharit & Czaja, 1994). The classic study on the relationship between slowing component behaviors and performance outcomes was done by Salthouse (1984) on a typing task. In this experiment, Salthouse demonstrated that although age-related differences were found for the reaction time task, they were not evident in the typing task. He believed that the older typists developed compensatory measures that enabled them to type as well as the younger typists. Findings from more recent studies indicated that age-related slowing had an impact on the performance of computer-based tasks (Sharit & Czaja, 1994). In this study, for three different tasks, the response times of the older subjects were longer than those for the younger group even when controlling for differences in computer experience and typing speed. However, in a follow-up study by Czaja and Sharit, age differences were still found for work output, but no differences were evident in accuracy for the data entry task after controlling for differences in work output (Czaja, 1999). These data indicate that more work is needed in this area to determine if better user interface and training methods could improve the older worker's performance.

Divided Attention

Other cognitive skills that are necessary for employees to perform satisfactorily in jobs as different as retail trade to nursing are attention and perception. For instance, in computer work, employees may be asked to monitor several computer screens simultaneously. Such tasks that involve that simultaneous managing of several windows of information may be more difficult for the older worker because they represent divided attention tasks (Sharit & Czaja, 1994). There are no conclusive data at this time to show how different windows designs could aid or hamper the older adult in the performance of various computer tasks.

Additionally, any age-related decrements in sustained attention tasks or visual searching may make some types of jobs more difficult for the older adult (e.g., telephone customer service). When we consider the work

environment as a whole, instead of just isolating the computer, the additional complexity of noise and other distractions are added. There is also some evidence that older adults may have problems selecting the relevant from the irrelevant information (Rabbit, 1965). This may be especially true in a service environment where simultaneous activities may place greater cognitive demands on the worker under sometimes severe time constraints.

Auditory

Decrements in hearing have the potential to impact work life as well as private life. For instance, there are predictable age-related increases in the auditory threshold and decreases in hearing at the higher frequency ranges. Recommendations for accommodating these losses include restricting the frequency of sounds to the 1000- to 2000-Hz range, and trying to eliminate reverberation (Charness & Bosman, 1994).

Vision

In general, older people suffer from a reduction in the range of accommodation, a loss in contrast sensitivity, decreases in dark adaptation, declines in color sensitivity, and greater problems with glare (Papalia et al., 1996). These changes have the potential to affect older workers in their day-to-day activities such as reading signs, driving, working at the computer, and reading medical forms. These vision changes may make some computer screens more difficult to navigate. In addition, poor work station design may place some terminals at heights that are more likely to cause glare for the older adult.

Combination of Physical Demands and Stress Levels

Health-Services Industry

Nowhere is the interaction between physical and cognitive work demands more evident and continuously intertwined than in the health-care services industry. The growing health-care services industry will provide challenges for both cognitive and physical ergonomics as the labor force ages and the demands placed upon them increase. Excellent studies, such as the Finn-Age project have studied home care and the aging workforce in Europe, but implications for possible ergonomic problems in the United States health care work force are staggering.

The situation of registered nurses, the occupation that comprises the largest group of health care professionals in the United States, with more than 2 million registered nurses employed in health care organizations in 1998, is especially dire (Buerhaus, Staiger, & Auerbach, 2000). The Bureau

of Labor Statistics predicts that by 2008, the demand for registered nurses will increase some 22%, thus adding 451,000 nurses to the work force (Braddock, 1999). However, the age structure of the registered nurse (RN) work force is older than many other occupations. Over the next two decades the largest cohorts of RNs will be between age 50 and 69 years. Within the next 10 years the average age of RNs is forecast to be 45.4 years, with more than 40% of the work force expected to be older than 50 years. By the year 2020, the RN workforce supply is expected to decline 20% below work force demands, because the baby boomers will be between the ages of 56 and 74 and most likely needing more medical care (Buerhaus et al., 2000). This will place additional burdens on those working in the nursing work force.

Within the nursing profession many ergonomic challenges exist. First, the common activity of nurses lifting patients leads to back injuries, with 38% of all nurses enduring back injuries at sometime during their career (Department of Labor, 1999). The results of European studies are even more staggering with nearly 80% of nurses having experienced at least one "life-time" episode of low back pain (Videman et al., 1984). Although many ergonomic studies have been done on reducing back injuries, they continue to exist with the potential to be of great cost to their employers. Secondly, nursing is a 24–7 occupation that requires the employee to work nonstandard hours. Night shifts and the rotation of shifts have been suggested to be more problematic to older employees than younger ones (Bourdouxhe et al., 1999). Third, the increasing trend towards more home health care will lead to the increase in the number of environments that are difficult to control from an ergonomic point of view.

The increasing physical and cognitive demands placed upon employees in the health services industry may likely increase the number of medical mistakes, having the effect of harming not only the employees but also the patients. In a recent report on medical mistakes, the Institute of Medicine estimated that as many as 98,000 people die in any given year from medical errors that occur in hospitals (Kohn, Corrigan, & Donaldson, 2000). As a means of comparison, this number represents more deaths from medical mistakes than occur from motor vehicle accidents, AIDS, or breast cancer. The report found that many of the mistakes are the result of a flawed system. Suggestions for research include the re-examination of the various systems and how to make them safer through enhanced knowledge, better tools to improve safety, and the breakdown of legal and cultural barriers that impede safety improvement. The implementation of ergonomics programs that help to keep the work force healthier and more alert will hopefully aid in reducing the number of mistakes. However, the current trend of over-working health care employees and the projections that suggest that certain fields will be understaffed have the possibility to lead to dire consequences.

At the same time that the baby boom generation reaches traditional retirement age, they may also be faced with caring for their elderly parents.

At this point there will be double the demands, as an older population may both need to work for themselves or to aid their aged parents. Ergonomic interventions will need to be directed towards paid and unpaid home care work.

Retail Trade and E-Commerce

Increases in the number of jobs in the retail trade will most likely affect the young and the old as young workers begin their careers and as older workers may take a retail position after their retirement from another profession. This trend can already be seen in companies, such as McDonald's and Walmart, that actively recruit older workers. For these occupations, differences in stress level due to working with the public under time-pressure situations should be analyzed. Additionally, these workers may not only experience manual material handling and HCI (human computer interaction) hazards, but also the static musculoskeletal stresses that come from standing for long periods of time. With the greater probability that more older women will be working, studies focusing on work ability, not just functional capacity, between the sexes will be valuable. New work management and environmental design will doubtless need to be initiated.

The growth in e-commerce will not only place older workers at the computer, but will most likely place them in warehouses and in the shipping business. Manual material tasks will increase with this new type of commerce. Lifting, reaching, pulling, and pushing tasks are common to this type of work. Physical changes, such as decreases in joint mobility, increased incidence of arthritis, and decreases in musculoskeletal strength, may all play a role in determining the work ability of the older employee in these types of jobs (Garg, 1991).

Increases in the number of hand packers and packagers (another top 30 on the occupations with the largest growth) may increase the risk of upper extremity musculoskeletal disorders (Braddock, 1999). Packing and packaging can be an especially stressful occupation because of speed with which the employee must work and also the fine motor skills that are required. Often times these packers and packagers may be predominately female, an important implication for the use of anthropometry in work place design. Current data have shown that in the laboratory spatial acuity of touch declines with age, but there has been no research done to demonstrate whether these declines affect work performance or even whether older workers who work more with their hands have the same general declines as the general population (Stevens & Cruz, 1996). Additionally, the focus required by the employee to work with such speed, and possible age differences associated with it, may be a fruitful area of study. With the location of many of the e-commerce warehouses in rural areas, population differences between the rural and the urban aging population may be important.

Transportation

Additionally, with the growth in home health care, practitioners will not only experience the direct work place hazards, but they will also experience indirect challenges, such as transportation. Research on the older driver should continue to be pursued, not only for those older adults driving for pleasure/shopping, but also for those older workers who will be commuting to work and within the work day. This fact is reinforced by the fact that truck drivers (both light and heavy) represent the sixth greatest occupation for job growth during the first decade of the 21st century (Silvestri, 1997). The increase in transportation research should include work on tactile sensations, glare, displays, signage, reaction times, seating, and musculoskeletal comfort.

CONCLUSIONS

The early part of the 21st century provides an unprecedented opportunity for those working in the field of aging and ergonomics. Not only will the baby-boom cohort be aging, but the combination of low birth rates with the expanding economy will mean that more workers may want or may have to remain in the work force longer than the now traditional age of 65. Additionally, the median age of the U.S. work force continues to increase and most likely will throughout the next several decades. The postindustrial American economy is expected to continue growing in the service industries, such as health care, business services, and retail trade. These growing sectors of the economy will continue to contain ergonomic hazards, but areas of especial concern are human-computer interaction, cognitive and ergonomic challenges in the health care workforce, and the increasing change in the structure of the older work force towards more women and minorities. Continuing the research and advances that ergonomists have already made in this field will ensure that the aging working population will remain healthy and active.

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