Changing Demographics of the Work Force

Implications for the Design of Productive Work Environments — An Exploratory Analysis

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This article describes the need for new research in the ergonomics arising from the changing demographics of the work force, and suggests some noteworthy implications for public managers and researchers.

It has long been recognized that developing a level of congruence between the actual work environment and the work environment preferences of the employee can lead to increased worker satisfaction, safety and productivity (Schneider, 1993; Coe and Ammons, 1993; Springer, 1992; Witt, 1992; Fernberg, 1992). The study of fitting the person to the job and fitting the job to the person is a major focus of the personnel discipline.

This article describes the need for new research in ergonomics due to the changing demographics of the work force, and suggests some implications for public managers and researchers regarding the interface between increased work force diversity and preferred working environments.

ERGONOMICS

The word ergonomics is derived from the Greek "ergon"—work, and "nomos"—natural laws of (IBM, 1986). The Polish scientist Wojchiech Bogumi Jastrzebowski (1799-1882) published a paper in 1857 which was devoted to the 'science about work'—a science which he named ergonomics (Franus, 1991). The name "ergonomics" appeared for the second time in 1949 when the Ergonomics Research Society was estab-

lished in England. The creation of ergonomics as a formal discipline occurred some forty years ago as a result of situational analysis of military engagements. The original definition of ergonomics is as important now as it was then—namely, the application of anatomical, physiological, and psychological knowledge to the problems of people at work (Leamon, 1987).

Another definition of ergonomics is "any device or action that makes workers more productive and comfortable in the workplace" (Bers, 1992). Roger Stephens of the Department of Labor Occupational Safety and Health Administration (OSHA) describes ergonomics as an analytical mechanism of trying to assign science and mathematical tools to designing jobs to fit workers rather than force-fitting workers into jobs (Schwind, 1992). Ergonomics matches the task, the tool, and the environment to fit the needs of the worker. The goal of ergonomic design is to optimize the needs of the worker and the organization to achieve a healthy, productive workplace (Allie, 1994).

An ergonomic approach to task analysis expands the scope of traditional methods by evaluating, step-by-step, how the human operator interacts with machine, product, system and work environment. This analysis helps determine whether task demands match or exceed human capabilities. The single most useful tool for meeting organizational objectives is a systematic analysis of work performed, one that leads to procedures and practices which ensure that work is consistently and properly performed.

The Importance of Ergonomics

Managers are finding that a knowledge of ergonomics can save money by improving productivity and reducing sick time. Ergonomist T. J. Springer points to a firm that increased productivity six percent by repositioning computer terminals and altering light fixtures. Michael Brill of the Buffalo, New York Organization for Social and Technological Innovation found that if an employee perceives a loss in comfort from office furniture, productivity drops $701 per employee based on a $31,600 annual salary (Paznik, 1987).

Serious implementation of ergonomics has taken place only at large businesses or when spurred by worker demands. Providing a comfortable workplace is the responsibility of all companies, but cost constraints mean that most office changes must be accomplished gradually. Careful planning must precede any acquisitions geared to improving ergonomics; the best use should be made of existing equipment and fixtures. Employees must be asked what changes in the workplace would improve their attitudes and performance (Oddsen, 1985).

Organizations implementing ergonomic policies save money via:

1. increased individual and collective productivity;
2. reduced job turnover, training and recruitment costs; and
3. reduced sick leave and health care

costs.

Eric Lund of 3M Co., for example, believes that human factor engineering is good common sense because it gives workers the facilities to do their jobs. Marvin Dainoff of the Center for Ergonomic Research at Miami University points to a growing body of evidence that clearly validates the long-term, bottom-line benefits of ergonomic design (Durante, 1989).

Linking Ergonomics and Work Force Demographics

The importance of ergonomics has been recognized in the business sector to the extent that standards have been set for optimal lighting levels and noise tolerance levels (for example see McCormick, 1976 and Huchingson, 1981). A concern of these authors, however, is the validity of previous findings about the changing demographics of the work force. Moreover, since many ergonomic elements are associated with specific attributes of the work force, i.e., age (Flattau, 1987; Witt, 1993; Marley, 1994; Garg, 1991; Chaffin, 1991; Young, 1991; Pandolf, 1991;) or gender (Flanagan, 1988; Czaja, et al, 1987; Gupta, 1985; Kiesler and Finholt, 1988), renewed emphasis must be paid to this topic in light of the dramatic increase in work force diversity reported in the next section.

DEMOGRAPHIC CHANGES IN THE WORK FORCE

In 1987, the Hudson Institute published "Work Force 2000," a report that has become an essential reference book for the human resources management community despite some critical reviews and somewhat tenuous predictions. Among the demographic "facts" that the report said would shape the economy and the work force of the future were: (1) a continued "feminization" of the work force (i.e., a growing percentage of the work force that is female); (2) the increasing representation of ethnic minorities in the work force; and (3) the aging of the work force (Johnson, 1987).

Increased Proportion of Women in the Work Force. During the 1980s, women accounted for more than 70% of growth in the labor market (Friedman, 1987). By the year 2005, women will make up approximately 47.4% of the total work force (Fullerton, 1993).

Increase in the Percentage of Minorities in the Work Force. The growing percentage of minorities in the labor force has been an important development during the past several decades, and the Bureau of Labor Statistics projects a continuation of this trend. The proportion of white non-Hispanics in the labor force will decline because all of the other labor force groups—African Americans, Hispanics, Asians and others—are projected to increase at a faster rate and to represent a larger share of the labor force in 2005. For African Americans, this is an expansion from a 10.7% share of the labor force in 1990 to 11.0% by 2005 (Fullerton, 1993).

Aging of the Work Force. The 55 and older population is expected to expand, as those born in the 1940s reach this age.

In the years between 1990 and 2005, the number of men in the labor force who are age 55 and over is projected to grow by 3.5 million (or 31 percent) and the number of women of the same age will increase by 3.8 million (or 47 percent). This compares to an increase in the overall labor force for the same time period of only 21 percent (Fullerton, 1993). By the end of this century, only 39% of the work force will be under age 35, compared with 49% now. Moreover, the number of people aged 50 to 65 will increase at more than twice the rate of the overall population (Ramirez, 1989).

The 39 million workers aged 35 to 44 will dominate the labor force at the turn of the century. But the share of workers aged 45 to 54 will also rise. Fifty one percent of the work force will be between the ages of 35 and 54, and 11 to 13 percent will be over 55. In 1970, the median age of employees was 28, by the year 2000, it will be nearly 40 (Kelly, 1992).

A comprehensive review of work force demographic changes and their implications for public administrators can be found in Wooldridge and Maddox (1994).

IMPLICATION OF ERGONOMICS FOR RESEARCH ON WORK FORCE DIVERSITY

In 1976 Dunnette pointed out that one of the major gaps in the field of organizational psychology was that no extensive coverage was given to groups such as women, minorities or the disadvantaged. Despite recognition of the growing diversity of the work force, this gap still exists. For example, in the matter of racial diversity, Cox and Nkomo (1990) surveyed twenty major management journals that published organizational behavior research between 1964 and 1989 and found that the amount of total published research is small relative to the importance of the topic. They also found that the topics covered are not representative of the domain of organizational behavior. Amazingly, they concluded that the trend is for **less** rather than more research on these topics. Frideger (1992) agrees and argues that, with very few exceptions, research in organizational behavior has generally disregarded the domestic, cross-cultural, and interracial implications of its theories.

> Not surprisingly, some demography researchers have emphasized the following: (1) the need for developing an understanding of the effects of racial and gender diversity in the organizational content, particularly as this increasing diversity impacts individuals who are members of what have traditionally been the dominant majority group in organizations; and (2) the need for understanding the relationship between demographic attributes and process variables such as communication, conflict, influence, and decision-making (Tsui and Egan, 1992).

It is conventional wisdom that all individuals are different. However, "(l)ife attitudes are not randomly distributed through the population. Members of the same 'identity groups', say the same age,

gender, race and such, have had overlapping life experiences which may, in turn, predispose them toward more or less favorable attitudes about particular company practices and cultures" (Marvis and Kanter, 1991). Differentiation is very important in this type of research for it must be recognized that differences exist even within the same large demographic group. Married workers put different values on the flexibility of their work schedule than do single workers, for example (Marvis and Kanter, 1991).

It is because of these potential differences that this article was written.

ERGONOMIC PREFERENCES OF A DIVERSE WORK FORCE

Data on preferences for certain workplace environmental factors were collected from more than 85 graduate students in the Department of Public Administration at Virginia Commonwealth University. Their characteristics are summarized in Figure 1.

Instrumentation

Data were gathered using the Productivity Environmental Preference Survey (PEPS) developed by Gary Price, Rita Dunn and Kenneth Dunn (1982). This instrument claims to be the first comprehensive approach to the analysis of an adult's individual productivity preferences. Further, the instrument aids in prescribing the type of environment, working conditions, activities and motivating factors that would maximize individual output. The PEPS analyzes an individual adult's personal preferences for each of twenty-one different elements. The twenty-one areas are:

1. Sound
2. Warmth
3. Motivated/ Unmotivated
4. Responsible
5. Learning alone
6. Authority-Oriented
7. Auditory
8. Tactile Preferences
9. Requires Intake
10. Late Morning
11. Needs Mobility
12. Light
13. Formal Design
14. Persistent
15. Structure
16. Peer-oriented
17. "Several Ways" learner
18. Visual Preferences
19. Kinesthetic
20. Evening-Morning-Preferences
21. Afternoon

Those elements with the highest reliabilities (>.75) include: "sound," "light," "needs mobility," and "likes formal design."

The elements with reliabilities > .50 include: "temperature" and "structure."

Individuals may be given the PEPS in writing, on tape, or orally. In this study a written "optical-scan" version was used. The questions are answered on a Likert Scale: strongly agree is a 5 and strongly disagree is a 1. Since there are questions that, if pondered, could cause modifications, limitations, and exceptions in responses, respondents were encouraged to give immediate reactions to each question on a "feeling" basis. The entire questionnaire need not be completed in one sitting, but may be responded to at intervals that are convenient to the individual. The estimated time to complete the survey is 20 - 30

FIGURE 1
DESCRIPTIVE DATA

	Male	Female	Total
White	41	24	65
Black	5	17	22

Age Distribution

N=87	Mean=33 years	Standard Deviation=7 years	
Age</=30	30<Age </40	40<Age	</50 50<Age
N=36	N=36	N=15	N=0

minutes.

The PEPS is returned to Price Systems, Inc. Lawrence, Kansas for scoring. A computerized, individual profile of each student's response to the PEPS is provided. Each profile contains (if completed on the answer sheet) the individual's name or identification number, sex, the date the answer sheet was scored, group identification, raw score, standard score, PEPS area heading, and a graph of the relative location of each person's standard score in each area. The standard score scale ranges from 20 to 80, with a mean of 50 and a standard deviation of 10. The standard score is calculated based on the scores of adults who have taken the PEPS. Individuals having a standard score of 60 or more strongly prefer that factor when they study or work. Individuals having a standard score of 40 or less do not prefer that factor when they study or work (Price, Dunn and Dunn, 1982). The developers of this instrument have suggested pedagogical strategies for individuals having standard scores of 40 or below, or of 60 or above for each of the 21 workplace environmental preference elements (Price, Dunn and Dunn, 1982).

It was decided to focus on six of the work environment elements measured by PEPS since they are featured more frequently in the literature on ergonomics (see Huchingson, 1981; Hancock and Pierce, 1984; and McCormick, 1976). These elements are light, sound, warmth, formal design, structure, and need for mobility. A description of each of these elements (as provided by Price, Dunn, and Dunn) is given below:

Noise Level-Quiet or Sound. Some people need quiet when they are working, while others notice neither noise nor movement once they begin to concentrate; they can "block out" sound. Some people need sound; they invariably turn on a radio, stereo, or television when they study as a screen against random noise distractions.

Light-Low or Bright. Some people work best under very bright light, whereas others need dim or low light.

Temperature-Cool or Warm. Many employees "can't think" when they feel hot, and others can't when they feel cold; some concentrate better in either a warm or cool

environment.

Design-Informal or Formal. Many employees think best in a formal environment, seated on wooden, steel or plastic chairs like those found in conventional classrooms, libraries, or kitchens. However, some work better in an informal environment, on a lounge chair, a bed, the floor, on pillows or on carpeting.

Structure-Needs or Do Not Need. This element involves an employee's need for specific directions or explanations prior to undertaking or completing an assignment.

Mobility. How quietly can the person sit, and for how long? Some people need frequent breaks and must move about the work environment. Others can sit for hours while engaged in work, particularly if they are interested in the task.

LIMITATIONS OF THIS STUDY

Clearly, this type of research suffers from a number of limitations. It is the existence of these limits that resulted in the study being referred to as an "exploratory analysis." First, the participants were not randomly selected, which negates the external validity of the study. Second, the number of participants, although greater than ten times the dependent variables, was small (87). Third, only one instrument, the Productivity Environmental Preference Survey (PEPS), was used to gather data, which casts suspicion on the internal validity of the study. The range of the age of the subjects was limited, with no subject being older than 50, and only 15 subjects being between the ages of 40 and 50. Next, the participants were students in a classroom setting rather than actual workers in their workplace; this results in "laboratory" research as opposed to field research (Locke, 1986). Support for the generalizability of laboratory findings (using college students as subjects) to the real world is provided in the excellent volume *Generalizing from Laboratory to Field Settings* (Locke, 1986). Locke concludes that "... what is needed when trying to determine the legitimacy of generalization is the identification of the essential features of field settings that need to be replicated in the lab ..." (Locke, 1986: 7).

Research reported in the areas of industrial organization psychology, organizational behavior and human resource management found that many findings replicate across both laboratory and field settings (Locke, 1986). In addition to the rationale already presented, another factor in selecting the six work environmental elements chosen in this study is the belief that they stimulate similar responses either in the laboratory or in the "real world." Finally, the study, as previously pointed out, examined only six of the many work environment elements that make up the legitimate study of ergonomics. In addition to these elements, studies of ergonomics include the causes of cumulative trauma disorders (CTDs) or repetitive strain (or stress) injuries (RSIs) (Allie, 1994), issues dealing with posture and standing (IBM, 1986), sitting (Allison, 1992), the back, the hand (especially in regard to Carpal Tunnel Syndrome), and video display terminals (Brenner, 1991). Thus, this study only dealt

with a small part of ergonomics.

Research Questions

The study explores the following research questions:

(1) Do the preferred work environmental elements of light, sound, warmth, formal design, structure, and need for mobility, as measured by the Productivity Environmental Preference Survey, differ according to the race (black, white) gender (male, female) or age of the employee? (2) What are the implications of these differences in preferences for public managers (for those interested, a more formal statement of the research hypotheses and statistical analysis can be found in the appendix).

Findings

In answer to the research questions posed, the findings of this study suggest that females clearly prefer more light than males. There is a trend in the findings that suggests that females might prefer less noise and higher temperatures as well. There was no evidence to support the possibility that females and males differed in their preference for the workplace environmental factors of formal design, structure and/or need for mobility. Nor was there evidence to support the possibility that there were different preferences based on race or age for any of the six workplace environmental factors (light, sound, temperature, formal design, structure and/or need mobility).

DISCUSSION

In response to the findings of this study, one might conclude that while there are some ergonomic preference differences related to work force demographics, for most of the ergonomic workplace environmental elements examined in this study there appear to be no differences based on the demographic factors of gender, race and age. This should be somewhat reassuring to public managers since it reduces the number of factors that must be considered when planning to accommodate the differences of an increasingly diverse work force. These ergonomic findings are also in contrast to the differences in management style, communication patterns, values, and other preferences that have been associated with different identify groups and reported in the literature (Wooldridge and Maddox, 1994).

As far as the differences that were identified in this study, Price, Dunn and Dunn (1982) suggest providing work-places opportunities near windows, under bright illumination, or adding table or desk lamps. They also advocate providing silent areas, individual office alcoves with sound proofing, or even providing ear plugs to block sound if necessary. Finally, in response to the trend towards a significant difference for females to prefer a higher temperature, public managers might provide work place opportunities that feature adequate heating, enclosures, screens, supplemental heaters and placement in warmer areas. Managers should allow sweaters, and use warm colors and textured materials (Price, Dunn and Dunn, 1982: 6).

IMPLICATIONS FOR FUTURE RESEARCH

Despite the limitations of this study discussed earlier, this study should still stimulate more research by public administrators into the possible differences among the preferences of different identity groups for productive work environments. First, this study presents an overview of the literature that emphasizes the importance of ergonomics to worker productivity. Discussion of ergonomics has been minimal in the public administration community since the 1950s. Perhaps this study will increase the visibility of this important topic. Second, the suggestion that there are some differences related to demographic factors calls for more research related to ergonomics and work force attributes. The results of this study raise doubts as to the ability to generalize across demographic groups the ergonomic standards set for light and sound (McCormick, 1976 and Huchingson, 1981). More research must be conducted exploring the relationship of these standards and the various "identity groups" that are emerging in importance in the work force. In addition to the six ergonomic workplace environmental elements used in this study, additional research needs to examine for possible relationships between demographic attributes and such ergonomic elements as standing and sitting posture, job design, design of tools, and the design of office furniture. This current study could be replicated using a randomly selected larger population. The research possibilities examining the possible linkages between work force demographics and ergonomic elements should keep many scholars busy for the foreseeable future.

CONCLUSION

Public managers must realize the importance of the work environment to the safety, satisfaction, and productivity of the workers. Experience has shown that an emphasis on a productive workplace does not cost money, it saves by increasing productivity, and reducing injuries, fatigue and absenteeism (Springer, 1992; Leamon, 1987). Likewise public managers should manifest their recognition that one work environment does not fit all employees. As the work force becomes more diverse, public managers must become diagnosticians, realizing that members of different identity groups in the work force might require different work environments in order to contribute fully to the organization's mission.

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Appendix

RESEARCH QUESTIONS

Do the preferred work environmental elements of light, sound, warmth, formal design, structure, and need for mobility, as measured by the Productivity Environmental Preference Survey, differ according to the race (black, white), gender (male, female), or age of the employee? What are

TABLE 1
GENDER

	FEMALE		MALE			
	Mean	*Std Dev*	*Mean*	*Std Dev*	*F*	*Pr.>F*
Element						
Light	56.073	7.104	51.087	8.846	8.269	0.0051*
Noise	49.732	9.354	53.065	9.583	2.683	0.1051
Temp	49.610	10.193	46.022	7.200	3.656	0.0592
Design	50.902	7.889	49.174	7.040	1.166	0.2832
Struct	52.463	10.845	53.978	9.382	0.488	0.4867
Mobility	50.561	8.527	52.891	8.084	1.711	0.1944

TABLE 2
RACE

	BLACK		WHITE			
	Mean	*Std Dev*	*Mean*	*Std Dev*	*F*	*Pr.>F*
Element						
Light	53.636	8.627	53.370	8.399	0.016	0.8984
Noise	53.727	7.959	50.739	9.997	1.615	0.2072
Temp	49.545	10.299	47.092	8.331	1.261	0.2647
Design	51.864	6.342	49.354	7.743	1.880	0.1740
Struct	51.773	12.012	53.769	9.371	0.644	0.4246
Mobility	49.727	9.553	52.492	7.830	1.829	0.1799

the implications of these differences in preferences for public managers

RESEARCH HYPOTHESES

Group I Hypotheses (Gender). As a group, females will have statistically different preferences for the selected work environmental elements of (a) light, (b) sound, (c) warmth, (d) formal design, (e) structure, and (f) need for mobility, than do males.

Group II Hypotheses (Race). As a group, blacks will have statistically different preferences for the selected work environmental elements of (a) light, (b) sound, (c) warmth, (d) formal design, (e) structure and (f) need for mobility, than do whites.

Group III Hypotheses (Age). There are statistically significant relationships between the age of the respondent and preferences for the selected work environmental elements: (a) light, (b) sound, (c) warmth, (d) formal design, (e) structure, and (f) need for mobility .

Group IV Hypotheses (Combined Profile). (a) blacks and whites, (b) females and males, (c) and

TABLE 3
AGE

	Group 1 >30		Group 2 30< >40		Group 3 40< >50	
	Mean	*Std Dev*	*Mean*	*Std Dev*	*Mean*	*Std Dev*
Light	53.417	8.996	52.806	8.555	55.000	6.729
Noise	50.889	9.456	51.694	10.284	52.467	8.509
Temp	47.806	9.701	47.222	6.875	48.667	11.330
Design	48.333	8.076	51.194	7.375	49.867	5.963
Struct	54.250	11.530	53.333	9.429	50.733	7.648
Mobility	51.000	9.238	52.4167	8.058	51.000	6.969

	df=2, 84	*F*	*Pr. > F*
Light		0.355	0.7019
Noise		0.154	0.8573
Temp		0.141	0.8688
Design		0.902	0.4096
Struct		0.642	0.5287
Mobility		0.188	0.8293

respondents of different ages, do differ significantly in their preferences for work environments as characterized by the combined elements of light, sound, warmth, formal design, structure, and need for mobility.

A total of 21 null hypotheses were tested. One-way analysis of variance (ANOVA) was employed to make comparisons of male and female subjects, black and white subjects, and subjects grouped in age brackets less than or equal to 30 years, greater than 30 years, but less than or equal to 40 years, and greater than 40 years but less than or equal to 50 years. (Hypotheses I, II and III). Multiple discriminant function analysis was used to test the null hypotheses for Hypothesis IV. The .05 level of significance is established as the criterion for hypothesis validation.

FINDINGS

Gender

As Table 1 shows, there was a significant difference between the gender groups' scores on the work environment element of light, ($F=8.2687$, $df= 1/85$, $p = .0051$). A comparison of the means for each gender shows that females prefer more light than males. There is a trend towards significant differences in regard to the element noise, ($F= 2.6826$, $df = 1/85$, $p = .1051$) and temperature, ($F = 3.6559$, $df = 1/85$, $p = .0592$). Again, a comparison of the means for these two elements show that females prefer less noise and higher temperatures. Findings would not permit the rejection of the null hypotheses for the other work environmental elements.

The Wilks lambda statistic indicated that the mean vectors associated with the environmental work elements did differ significantly in

terms of gender (Wilks lambda = 0.0018, F (1,85) = 3.9090, P = .0018). Thus, the authors rejected the null hypothesis that stated females and males do not differ significantly in their preference for work environments as characterized by the combined elements of light, sound, warmth, formal design, structure, and need for mobility.

Race and Age

Findings did not permit rejecting any of the Group II or Group III, null hypotheses (See tables II (Race) and III (Age) below). Thus, no evidence was found to suggest linkages between these environmental work elements and age or race.

The findings of multiple discriminant function analysis did not permit the rejection of null hypotheses IV-A and IV-C; that is, there was not a significant difference between African-Americans and whites in their preferences for work environments as characterized by the combined elements of light, sound, warmth, formal design, structure, and need for mobility (Wilks lambda = 0.9243, F (1,85) = 1.0921, P = .3744). Also, respondents of different ages did not differ significantly in their preferences.

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