Human Performance: Psych 436
Fall, 1996

Instructor: Keele
Office: 221 Straub,Phone: 6-4931
e-mail: skeele@oregon
Office Hours: 9:00-11:00 M-F

Lecture Topics	Readings
I. Introductory Concepts and Methods	Wilson (Pk 1)
A. Human Performance and Human Factors	BARBER CHAPT. 2
B. Reaction Time, Mental Processes, and Applications	Keele (Pk. 2: sect. 1) Dewar & Ells (Pk1) BARBER CHAPT. 4 Lewis & Baddeley (Pk 1)
II. Topics of Human Performance	
A. Attention, Memory Codes, Reading	Barron (Pk 1), Rayner (RBR), Miller (Pk 1), Nickels (RSR), Ladavas (RBR), Stablum (RBR) BARBER CHAPTS 5 & 6
B. The Concept of Executive Process	
C. Motor control	Keele (Pk 2: sections 2, 3.3.4, 4
D. Memory & Skill (reading only--no lectures)	BARBER CHAPT. 3 Ellis (RBR) Ericcson & Chase (Pk 1)

Course theme: The course lectures emphasize topics in Cognitive Psychology, including topics related to Motor Control. The overall course, however, emphasize the application of methods and theory developed in Cognitive Psychology to practical problems. Lectures provide several examples of such application, and the two major halves of the course culminate in examples in which basic theory of cognitive psychology leads to important applied ideas. The readings have an even heavier applied theme. The book provides more general coverage of applied cognition, including topics that will not be addressed in lectures. The packets of articles are primarily extracted from orginal research reports, and in each case they develop an application that grows out of cognitive psychology. Exercises and term paper emphasize applying ideas from cognitive psychology.

READINGS: The primary text for the course is by Barber entitled Applied Cognitive Psychology. Because this book is out-of-press, awaiting a 2nd edition, it is available in copied form and sold through the book store. A few used copies might be available at bookstores. Additional readings involve articles emphasizing applications of cognitive psychology to a variety of problems. Some are in a packet sold at the bookstore and referred to above as Packet (Pk) 1. A chapter by the course instructor (Keele) may also be bought at the bookstore (labeled Pk2 above). Purchase of this chapter is optional. It provides information covered in some sections of the course. No questions on exams will be asked regarding this chapter which cannot be answered by attending lectures, but the chapter can be used to bolster the lectures. Five articles, those by Rayner, Nickels, Ladavas, Ellis and and Stablum (first authors only are noted) will not be in the bookstore packets because of excessive cost charged by the publisher. These will be available in separate packet at the Reserve Book Room (labeled RBR above) and also can be borrowed briefly from the instructor for xeroxing.

Exams: There will be a 1-question quiz (Oct. 24) a midterm, and a final exam. The quiz score will be added to the midterm scores to determine the midterm grade. Exam questions will be essay, some requiring short answers and some requiring longer answers. Choices will be available on the main exams, but **always** some questions must be answered based on the readings and some on lectures. That is, you will not do well in the course unless you both read the materials and attend lectures. The exams will account for 67% of the final grade.

Design Flaws: In your encounters with your environment, you must identify two design flaws fror a Human Factors viewpoint. Each flaw requires a description not to exceed 300 words. These must clearly be of a human factors nature and not a purely engineering flaw. The first may deal with either failure to observe what we will call a body limitation or an information processing limitation. The second must deal with an information processing limitation. The flaw descriptions will be graded on a P/N basis, and their success or failure will influence borderline grades in the final grading. If you receive an N, you are encouraged to redo the exercise to have the grade changed. In writing up the flaw, you must describe the problem and justify why you think it is a human factors flaw rather than an engineering flaw. What is it about the flaw that overtaxes body limits, causes reaction time to be slow, or impinges on memory limitations, etc.? Then you must suggest a reasonable way of correcting the flaw.

Option to Design Flaws: Instead of two design flaws, you may do a more extensive analysis o a single problem. Such analysis can be done with a small group. Each person in a group might read an article or two or investigate a part of a problem and then write a component of a small group report. Each person might be expected to contribute a page or two to the report, but the report would be graded on a P/N basis for the group as a whole. Here are some possible topics (others can be considered):

1. A considerable amount of discussion and research has been concerned with the effects of a increasingly aged population on driving. Some research considers objective indices of decline in information processing abilities related to driving as a function of age. Some research looks at accident rates. Some research looks at counseling approaches based on assessment of information processing abilities. Some looks at possible human factors improvements. A group working on this would divide up a few readings and then write a sma report, describing the problem and giving recommendations for dealing with the problem. One literature source is a special issue of the Human Factors journal, October 1991.
2. A recent article in Ergonomics Design, claimed that elastic back supports worn like an article of clothing and intended to reduce on-the-job back injury are worthless. I was therefore interested to see that employees of Coastal Farm Supply and of Home Depot were using such supports, even under conditions where people were uncomfortably hot. This topic migh be looked into a little further. You could inquire why the companies require their employees t use the belt. You should read the target article and decide whether the company policy is justified or not. Another more recent article in Human Factors suggests there might be limitec circumstances in which back supports might be useful.
3. Faculty members and students in psychology and other social sciences have complained that the Library of Congress numbering system, used by the Knight library makes finding of research materials difficult, especially for journals. The alphabetic filing system of the Science library is thought to be easier. The alleged problem might be documented by interviewing a few faculty members or students, doing some analysis of how material is found in the two libraries, and conducting a small "experiment" to measure search time and xerox time for material.

4. As the university increases the usage of Web sites to provide information (syllabi, reading lists, course communication etc.) we might anticipate enormous human factors issues. A small scale analysis of problems and some suggestions for organizing university Web sites would make a good project.

Term Paper: A term paper is due the last Thursday before finals week. The paper will account fo 33% of your final grade. The paper should be based on either library research or a combination o library and field research. The intent is to pick a topic of interest to you in which concepts from cognitive psychology or human performance might be applied. To choose a topic, think about you major. If it is other than psychology, such as business or education, then choose some problem within that major, such as advertising or consumer interests for business majors or developmental dyslexia for education. Then do research on some linkage between your chosen interest and cognitive psychology. If you choose advertising, you might review literature on factors that influence attention-getting power and memorability. If you choose dylsexia, you might review literature that stresses current concepts from cognition and that help interpret and propose solutions for childhood dyslexia. If your major is psychology, then you might think about your special interests within psychology and try to think of a link. For example, if you are interested in organizational psychology, there is some literature on a human factors approach to organizations. Another possibility is to think in terms of other major interests, such as environmental issues or learning of foreign languages. For topics of this sort, one can find a literature that links cognitive psychology to the issue.

Here are some possible topics. You may choose others.

A. Aging

1. Recent conceptions of aging and cognition
2. Human factors design for the elderly
3. Strategies of neuropsychological rehabilitation (Note: the problem of strokes and neurological disease increases with age. Does an understanding of the cognitive problems suggest rehab strategies? See articles in reading by Nickels, Rayner, Ladava.
4. Dealing with the problem of the aging driver.
5. Does increased physical exercise improve *cognitive* fitness in the aged.

B. Cognition and Education

1. Implications of memory research for foreign language learning. **Note:** quite a bit of interesting work exists on how age of acquisition of a second language affects acquisition o different features of what is learned-- semantics, syntax, phonology.
2. Analysis of developmental dyslexia from a cog psych view point and implications for instruction
3. Strategies of teaching reading from a cognitive psychology perspective **Note:** see recer book by Marilyn Adams entitled "Beginning to Read".
4. Cognitive analysis of arithmetic and implications for education **Note:** there appears to be a good body of cross cultural work appearing, and some of it concerns different ways of teaching numeric concepts.
5. Individual differences: abilities or learning? **Note:** a dominant theme of skill in recent years has been that differences in skill level are primarily a product of learning. A recent Psych. Rev. article by Ericcson & Krampe is a good starting point, as is the article on the reading list by Chase & Ericcson. For a range of viewpoints, see a recent book by Starke and Allard (1993) entitle Cognitive Issues in Motor Expertise. The topic might be especially valuable for students of exercise and movement science.

C. Computer topics: much is available on the human factors of computer systems.

D. Automobile Accidents: A major cause of human suffering comes from automobile accidents. Psychology is becoming increasingly useful in the reduction of accidents as suggested by some of the readings. There are several topics possible here or several subtopics could be emerged into one.

1. The problems of the aging driver and the young driver. Young drivers may not only be "reckless" but actually lack certain skills (see evidence on nature of skill). What can be done about these driving for these two groups?
2. Problems of attention and alertness in driving: Evidence has accumulated that sleepines is one of the major causitive agents of driving. A recent article in the in Neural Computing & Applications suggests how a neural network learning system might be able to monitor alertness from driver behavior. Certain drugs (alcohol) impair vigilance. There is increasing concern that use of mobile phones in automobiles is responsible for accidents. Such problems arise because mobile phones compete for attention. See coverage of that topic together with theory and some human factors suggestions in the Barber book. See also an article by McKnight in the journal Accident Analysis & Prevention, 1993 (p. 259). ATT Consumer Products also has a 1985 study available.
3. In general, anything that can be done to reduce reaction time for making driving decision would reduce accidents. Any of the approaches illustrated in articles in from the course can be expanded.

E. Other

1. Use of cognitive tasks in evaluating environmental pollutants (behavioral toxicology). Could involve analysis of smoking in workplace.
2. Implications of cognitive limitations for the judicial system: eyewitness testimony, jury decision making, etc. **Note:** a professor at Oregon State, Horowitz, has been doing interesting work on how to improve memory of jury members
3. Role of mental practice in learning physical skills **Note:** If you choose this topic, be sure to consult with the instructor to get some perspectives from Cognitive Psychology
4. Analysis of coordination and clumsiness from a cog psych perspective. A good starting place is a chapter by Jones in Starkes & Allard (1993) or an article by Lundy-Ekman in Journal of Cognitive Neuroscience.
5. Shift work and sleep loss and its effects on cognitive efficiency (or studies of dealing with jet lag). **Note**: a recent issue of Human Factors is devoted to shift work, and it would provide a good start. There is related material on adapting to jet lag.
6. As you will gather from the Stabum article in the readings, rather mild closed-head injuries (getting "knocked out" or less), can have residual effects on mental functioning, especially as related to functions of the frontal lobe of the brain. Cognitive Psychologists are now beginning to unravel aspects of frontal lobe function. There also is some accumulating work, I have heard, that suggests that even mild head injuries in sport, may have lasting mental effects. This raises important issues about soccer, where the head is used to butt the ball, football, boxing, etc. A project here might attempt to understand the concept of "executive function" and how it is measured, look a little at brain function, and then delve into literature on sports head injuries and other injuries.
7. Strategies for rehabilitation of "theory of mind" deficits in autistic children: I'm not certain whether sufficient literature exists in this field, but there is at least one very provocative article that suggests a scheme that would be useful based on the cogntive analysis of deficit.

The final project topic must be approved by the instructor (Nov. 12).

Important Dates:

First design flaw due: Tuesday October 8.
Second design flaw or option to design flaws: Thursday October 17
1-question quiz: Thursday, Oct. 24.
Midterm Exam: Approx. Nov. 12 or 14.
Paragraph description of Term Project topic: Nov. 12
Term project due: Dec. 5
Final Exam: 8 AM Wed. Dec. 11 **Note: no early final can be given. Scheduling departures for vacation before the final may result in an N.**

Select a Laserwriter

Sophocles
Newton

Select a Laserwriter

Brain EP Laser Printer 1
Cog & Dec Sci LW
Cog Lab Rm 12 Shared LW
Institute 1200C
Taylor 143
Video 347

This was a case of mistaking prop pitch controls for throttle controls in a C-47 while the pilot was flying a GCA. We were on the final approach at about 600 feet when we noticed an unusual sound in the engines. What had happened was that the pilot had taken hold of the prop controls and was using them for throttles. They were next to the pilot while the throttles were in the center. This was a bad installation also, because the gauge for the props was on the right of the manifold-pressure gauge while the prop controls were on the left of the throttle controls.

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The Centered High-Mounted Brake Light: A Human Factors Success Story

By Thomas B. Malone

We practitioners of human factors are able to point to a number of success stories. These are situations where the application of human factors resulted in measurable and sizable improvements in the performance of systems or the safety of people, and/or reductions in the costs of developing and supporting systems. The number of such events that are readily identifiable, however, is probably not as great as we would desire. If we do our job right and effectively integrate the personnel component into systems, an obvious payoff in terms of accrued benefits of human factors should result. Unfortunately, it is often difficult to identify, much less quantify, the payoff of human factors application where the human factors input is embedded in the system development.

A case in which the benefit of human factors is both readily apparent and quantified is that of the centered high-mounted brake light. Most people have no doubt noticed the presence of this component on all 1986 passenger cars sold in this country. It may be less well known, however, that the regulation requiring this light was the result of research conducted by human factors practitioners in the area of transportation safety.

According to the U.S. Department of Transportation (DOT), rear-end accidents comprise 25% of all multi-vehicle accidents and 7.4% of fatal accidents. Within the overall objective of reducing the frequency of motor vehicle accidents in general, and rear-end accidents in particular, rear lighting and signaling on motor vehicles has been a subject of theoretical, laboratory, and simulation studies since the late 1960s. Based on these investigations, a number of suggestions have been formulated for improving rear lighting systems by modifying color coding, number of lamps, lamp location, and other design parameters. Early work in these areas was done by Rudolph G. Mortimer at the University of Illinois, Thomas H. Rockwell at Ohio State University, Robert M. Nicholson, director of the Office of Crash Avoidance Research at the DOT National Highway Traffic Safety Administration (NHTSA), and Robert Henderson, then on Bob Nicholson's staff at NHTSA.

In early 1977, Mark Kirkpatrick and I directed a large-scale human factors field assessment of several brake-light configurations at Essex Corporation. The stated purpose of the study, which was sponsored by Bob Nicholson, was to determine if any of several proposed automobile rear lighting systems would result in fewer rear-end collisions when compared under actual traffic conditions with a typical existing configuration. The configurations tested included a centered high-mounted brake light, dual separated high-mounted brake lights, and a separated function condition in which a wiring change was made to existing vehicle lamps so as to separate the presence (tail light) function from the stop/turn functions.

A total of 2100 taxicabs in the Washington, D.C. area were partitioned into four equally sized groups: three experimental groups and one control group. After the rear lights on the cabs in the experimental groups were modified or the high-mounted lamps were installed according to the experimental protocol, a data collection phase was implemented wherein data on the rear-end collisions, other types of collisions, and mileage for all test vehicles were recorded over a one-year period. The four test groups accumulated nearly 60 million vehicle miles under a wide variety of weather and road conditions. Drivers in the several groups had been matched for age, sex, and prior accident history.

The primary finding of the study was that cabs equipped with a centered high-mounted brake light experienced an accident rate that was 54% lower than that for cabs in the control group. This finding was statistically significant at the 0.0001 level. Neither the configuration of dual high-mounted brake lights nor the separated function condition differed significantly from the control group, although both configurations produced apparent reductions on the order of 20%. An analysis was conducted of rates for accidents other than rear-enders during the data collection period, and these rates were found to be essentially equal across the groups. The rear-end rate effects were, therefore, not due to differences in general safety performance between groups. These results are presented in Figure 1, which shows rear-end and non-rear-end accident rates plotted as a percentage of the control group rate. The experimental group non-rear-end accident rates were greater than those for the control group, while all brake light treatments showed an apparent reduction in rear-end accident rates.

Not only did the centered high-mounted brake light reduce the incidence of accidents by more than half, it was also found to reduce the extent of damage to vehicles involved in accidents by 38%. This led to the conclusion that the centered high-mounted tail light results in faster brake application in the following vehicle, resulting in a

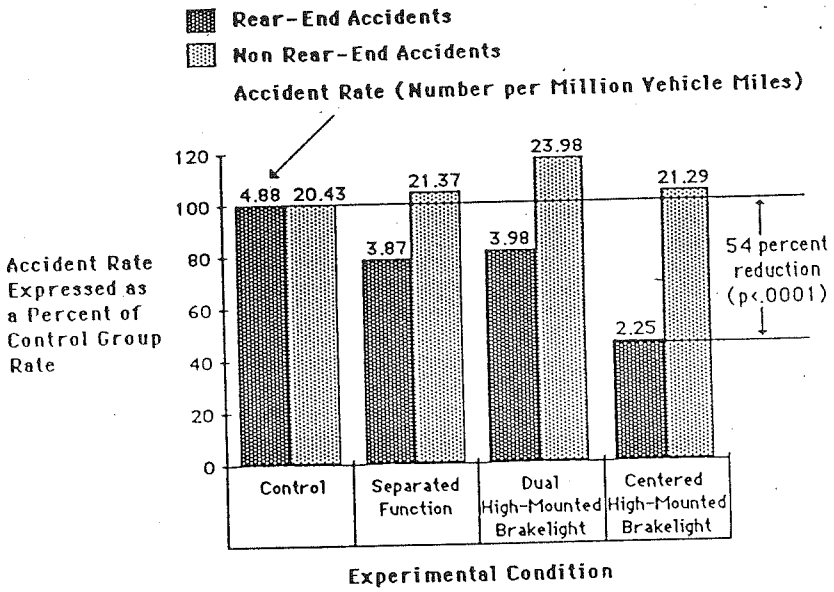


Figure 1. *Accident rates by experimental condition.*

slower speed at impact and consequently less damage to both vehicles.

An attempt was made by NHTSA to calculate the cost-benefit ratio or return on investment for the centered high-mounted brake light based on vehicle damage costs. It was estimated that there were 3.2 million accidents in 1977 that could have been affected by the centered high-mounted brake light. If the additional light had been in use, this figure would have been reduced by 54%, thereby preventing 1.7 million accidents. The savings represented by preventing these accidents was computed at 1.7 million accidents × $317 average cost of repair of control vehicles in the study × 2 vehicles, or $1,096 million. For each vehicle involved in the 1.5 million accidents that would still have occurred even with centered high-mounted brake lights in use, the savings in cost of repairs would have been $123 ($317 less $194, which was the average cost of repairing cabs with high-mounted brake lights in this study), for a total savings of 1.5 million × $123 × 2 vehicles, or $369 million. The total annual dollar savings accrued to the centered high-mounted brake light was then $369 million plus $1,096 million, or $1.465 billion. The cost of installing the centered high-mounted light was estimated at $4.00, and the total cost for 10 million vehicles was $40 million. The cost-benefit ratio is then 1465/40 or 37:1. This cost/benefit calculation is extremely conservative because it does not include medical, legal, or loss-of-work costs.

The results of this investigation were validated by the Allen Corporation in 1980, again for DOT NHTSA. This second study was directed by Raymond E. Reilly and used 5400 Bell Telephone System company vehicles divided into centered high-mounted brake light and control groups. The result was an accident rate reduction of 53% for the high-mounted brake light. A third study, sponsored by the Insurance Institute for Highway Safety, was directed by Mark Kirkpatrick. This study used 900 New York City taxicabs and substantially supported the two earlier investigations by reporting a 50% reduction in rear-end accidents due to the centered high-mounted brake light.

The implications of these findings for motor vehicle driver safety are immediately apparent. Based on accident statistics, it was reported in the original study that, with implementation of the centered high-mounted brake light, 1.7 million rear-end accidents would be avoided every year. The dollar savings accrued from the high-mounted brake light was computed at over $1.4 billion per year.

The statistical field test data show a consistent decrease in rear-end accident rate on the order of 50% due to the centered high-mounted brake light. Presumably, information about braking (i.e., deceleration) by a lead vehicle is transmitted sooner or more effectively when the centered high-mounted brake light is available as a cue. There are a number of plausible explanations for this. For one, the additional lamp provides greater signal area and intensity. Since the dual high-mounted condition provides even greater area and intensity but was found to be less effective, this argument is not very convincing. It has also been argued that the centered high-mounted location permits detection by drivers several vehicles back since it can be seen through a number of windshields and rear windows. This may be beneficial in multiple-vehicle "pile-up" accident situations This benefit should, however, also characterize the dual high-mounted condition. The centered high-mounted brake light is independent of the turn signals and provides an unambiguous brake signal. It also seems very likely that the centered high-mounted brake light position is a positive factor because it is close to the "straight-ahead" line of regard. Studies of eye movements and fixation points during driving have suggested that the fixation point shows large dwell times in the vicinity of the perspective point with rapid fixations to objects in the visual field and back. This suggests that the effectiveness of the high-mounted brake light may occur because it is located near the normal line of regard.

Based on the field test studies, DOT modified the motor vehicle safety standard to require that all passenger

Bathrooms for Living

The bathroom is the most important room in any house. It is the one place where people can be nude, solitary and mute for any protracted period. It is a refuge for all reasons, serving also as laundry room, solarium, greenhouse and primping parlor, a place for delousing pets, deep thinking and stashing wet umbrellas. Yet even in its more basic functions, the contemporary American bathroom is "hopelessly antiquated and inadequate," in the view of Alexander Kira, an architect and Cornell professor who has immersed himself in the subject for 17 years. Indeed, he points out, the Western loo has changed little since the late 19th century, when Thomas Crapper of London patented his flush toilet—and thereby insinuated himself into colloquial English.

In *The Bathroom* (Viking), a newly updated and expanded version of an urbane study he published in 1966, Kira argues that the standard bathroom is uncomfortable, unsanitary and unsafe. The average 5-ft. by 7-ft. model is badly lit and ventilated; it seldom provides adequate storage and counter space for all the tubes, jars, bottles, blades, brushes and electrical appliances that have become the indispensable artifacts of ablution. Clearly, if cleanliness is next to godliness, it is also next to impossible in bathrooms that lack "facilities for perineal hygiene," meaning bidets. Moreover, some 275,000 people in the U.S. are injured each year while using ill-designed tubs and showers.

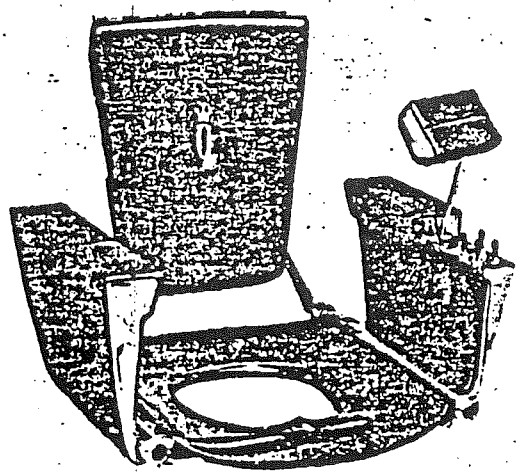
Wider Seat. Kira concludes from continuing research that the standard toilet is "the most ill-suited fixture ever designed," whether for comfort or efficient elimination. The whatchamacallit should be from 5 in. to 9 in. lower and shaped so that the occupant could take the natural squatting position of primitive man; it should also have a wider padded seat and incorporate two water jets for cleansing. Many washbasins, he finds, are built "so low as to be ideal only for small children." He proposes a contoured bowl, 36 in. high, deep at one end, wide and shallow at the other, with a fountain spout that can be used for mouth washing and shampooing.

The most frustrating fixture of all, in Kira's view, is the tub-shower. "The only substantive reason for taking a tub bath is to relax," he maintains, "and yet it is precisely this that the vast majority of tubs have not permitted the user to do." The tub should be longer (6 ft., *v.* the standard 5 ft.) and wider, have a contoured back to fit the curvature of the spine, a comfortable place to sit while foot washing and shampooing, and a hand spray for rinsing. Showers should be larger, have continuous wrap-around grab-bars and different-shaped handles located away from the water source so that the soap-blinded bather can adjust water temperatures by feel.

Why do we have such minimal, dismal bathrooms? Mainly, Kira contends, because we "have allowed our taboos and guilts to interfere with the fullest development and realization of our physical and mental well-being." Builders, eager to skimp on space, seldom conceive of the bathroom as an integrated system like the modern kitchen.

It was not always so. Princes and potentates once treated the toilet seat as an extension of the throne; it was from the gilded *cabinet* that France's Louis XIV announced his engagement to Mme. de Maintenon. (Even Lyndon Johnson was not above conducting affairs of state while moving his bowels.) Indeed, there are few places so conducive to intellectual exercise as a well-appointed bathroom. Lord Chesterfield advised his son that he "knew a gentleman who was so good a manager of his time that he would not even lose that small portion of it which the call of nature obliged him to pass in the necessary-house; but gradually went through all the Latin poets in those moments." Thousands of monastery manuscripts found a dual purpose ending in the toilets of the rich.

Shower Machine. As Americans have become increasingly frank about sex, Kira believes, they are also becoming more candid about the once unmentionable functions of the bathroom. "Whereas the '50s and the '60s were the era of the kitchen and the family room," he predicts, "the '70s will be the era of the bathroom and body care." The Japanese, who have always had a highly civilized attitude toward hygiene, already have a design for the ultimate shower machine: the bather selects the desired water temperature and soap, pushes a button and is then soaked, washed with suds produced by ultrasonic waves, rinsed, massaged with rubber balls and finally dried with heat lamps. A big step toward civilized johnmanship is the "AD 2000 Comfort Control Center," a prototype built by Olsonite of Detroit. Mounted on a conventional toilet, it provides a tilting, vibrating back, reading light, ashtray, radio, TV, timer and bidet attachment. To bring the bathroom back into the family—and vice versa—a West German firm has designed a *Wohnbad*, or living bath, to be shared by all. It boasts chairs, rugs, paintings, sun lamps and hair dryers, TV, bookshelves, sauna, telephone, refrigerator, bar and coffee maker. It does not stock Latin poetry, but the toilet paper has English-language lessons printed on it.



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Going Digital

Last year technology put pocket calculators under the Christmas tree. This year's great space-age spin-off is the digital watch. Hailed by one effusive manufacturer as "probably the greatest breakthrough in timekeeping technology since the sundial," the solid-state,