

Lecture of ME567A Gerontechnology, Yuan Ze University

Human factors in gerontechnology



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Human factors

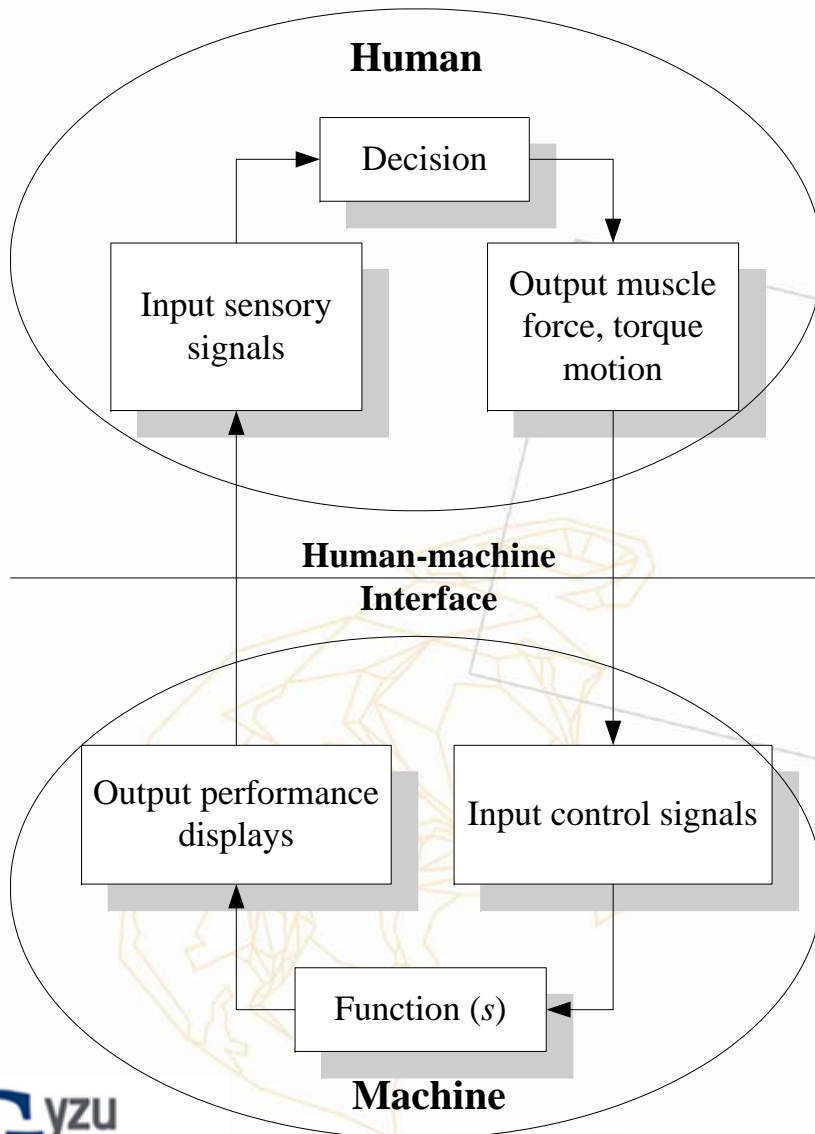
- ✓ Human factors is a term used to describe the abilities, limitations, and other physiological or behavioral characteristics of humans that affect the design and operation of tools, machines, systems, tasks, jobs, and environments.
- ✓ By careful consideration of human factors, designers hope to achieve user-friendliness, convenience, effectiveness, efficiency, and increased productivity.
- ✓ Designers also hope to enhance safety, reduce fatigue or stress, increase comfort and user acceptance.



Human factors design in technological products for the aged

- ✓ To determine the source of the difficulties that older adults were experiencing, Rogers et al. [1998] interviewed groups of older adults between age 65 and 80 and asked them about frustrations and difficulties they encounter when carrying out their normal daily activities.
- ✓ In 47% of the problems, older adults reported health problems or medical problems that were not likely to be remedied by any human factors intervention.
- ✓ 53% of the problems could potentially be solved by improvements in design, training, or a combination of the two.
- ✓ Designers must understand the perceptual, motor control, and cognitive capabilities of users, and in particular how such abilities change as a function of age.

Human-machine system



- ✓ Humans receive information about the current state of the machine and the environment via sensory input → Use this sensory information to make decisions → Implement their decision by applying an output force or torque to the machine → The machine performs the desired changes in function and displays new outputs.
- ✓ Human-machine interface

Human-Machine Interface

- ✓ An interface is any part of the machine that the human touches, sees, hears, or is exposed to.
- ✓ Designers must consider how humans interface with machines:
 - Identify and accommodate human limitations in detecting and interpreting sensory inputs
 - Accommodate the capacity of a human to correctly process information and make timely decision
 - Acknowledge human limits with regard to applying forces or torques
 - Fit the size of human

Visual input

- ✓ A poorly designed visual display could be confusing or or difficult to interpret.



- ✓ Visual display types include: indicator lights, continuous readout gauges, digital counters, and graphical panels.

Difficulties in processing visual information and design consideration (1/3)

- ✓ Older adults report difficulties in spatial vision, slowing of visual processing, seeing in poor light, seeing at near distances, and visual search.
 - Spatial vision is measured with acuity or contrast sensitivity.
 - Acuity refers to the ability to see fine details;
 - Contrast sensitivity is the ability to see small differences between the light and dark parts of an image.

→ Design consideration

- ✓ If visual information is crowded by other stimuli, moving too quickly, presented at low contrast, in small prints, or at the wrong viewing distance, older adults will have more difficulty using that information.

Difficulties in processing visual information and design consideration (2/3)

- ✓ An abundance of visual information outside of central vision can guide attention and eye movements, facilitate postural stability, and influence the perception of object and self-motion.
- ✓ Visual fields are reduced from approximately 180 degrees to 140 degrees by the age of 70. The “useful field of view (UFOV)”, the task-dependent spatial extent over which information can be extracted, is reduced with age.

→ Designer consideration

- ✓ In the display designed for technological products, such as automobile displays, major information should be properly arranged so that older adults do not have to make too much eye movements when searching for information.
- ✓ Viewing distance should be considered too.

Difficulties in processing visual information and design consideration (3/3)

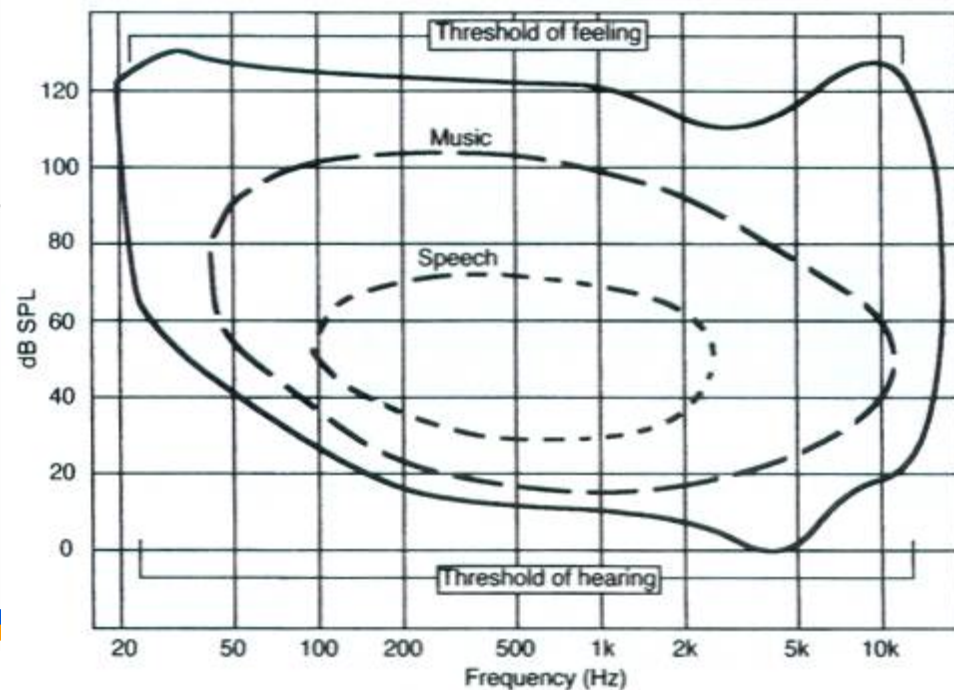
- ✓ Older adults have difficulties processing color information.
 - Color differences across a scene facilitate the separation of figure and ground, and are used to discriminate and identify objects.
 - Shorter wave lengths, corresponding to the blue range of the visible spectrum, are more difficult to discriminate, especially in poor illumination.

→ Design consideration

- ✓ If subtle color differences are used indiscriminately in technological applications, older adults will find them less accessible.
- ✓ Visual display designed for elderly people (such as website), should use colors of longer wave lengths, such as red and orange.

Audio input

- ✓ Humans hear frequencies between 20 and 20,000 Hz, and are more sensitive to higher frequencies.
- ✓ Auditory displays commonly used include bells, buzzers, horns, sirens, tones, and electronic devices that speak single words.
- ✓ Auditory displays should be avoided in noisy environment or when the operator is receiving too many other audio signals.



Difficulties in processing audio information and design consideration

- ✓ Hearing loss is a problem frequently observed and reported in older people. The eardrum loses its elasticity, resulting in a reduction of signal strength, and the small bones of the middle ear also become calcified, diminishing signal amplitude further.
- ✓ While signal strength can be increased using amplification at the sound source or hearing aids, many such devices amplify all signals including noise, an effect that prompts older listeners to discontinue their use.
- ✓ The ability to discriminate among frequencies is important to speech perception and is compromised in older adults.

Touch and Kinesthetic

- ✓ Examples of using touch and kinesthetic as input
- ✓ Older adults manifest a loss of sensation in various parts of the body including the feet, lips, fingers, and the fleshy area below the thumb. These include declines in sensitivity to pressure, spatial acuity, and the perception of roughness, length and orientation.
- ✓ In addition to these sensory deficits, changes in the joints and bones of the hand reduce grip strength and range of motion.
- ✓ Most hand-held devices, due to their smaller size, require fine, discrete movements to tap very small targets, to press small buttons, or to write with a stylus. The knobs and buttons also give little tactile feedback to indicate that they have been scrolled or depressed.

Human Decision Making Limitations

- ✓ The process of making decisions: receive sensory input information → interpret it → develop a set of choices → predict the outcome of those choices → evaluate the pros and cons → select the best choice.
- ✓ Simple reaction time and choice reaction time.
- ✓ Designers should make machine display appropriate visual and auditory signals clearly and quickly.
- ✓ The user should be trained to react to these stimuli in a safe and predetermined manner, by actuating the control that is clearly identified for the specific situation.
- ✓ Elderly people require longer response time for operating products or machines.

Difficulties due to cognitive aging and design consideration (1/3)

- ✓ Age-related memory decline is not universal. Specific types of memory decline with age whereas others are spared.
 - Working memory tasks require temporary storage and manipulation of information in memory. Several theorists have argued that capacity limitations, speed of processing limitations, and an inability to inhibit unwanted information may underlie the age-related decline in working memory [Craik, 2000].
 - Semantic memory refers to the store of factual information that accrues through a lifetime of learning. Age-related differences in the organization and use of semantic information are only slight or nonexistent [Light, 1992].

→ Design consideration

- ✓ Design strategies that capitalize on the existing knowledge base of older adults may result in more usable technology because device operation is more intuitive due to its consistency with prior knowledge.

Difficulties due to cognitive aging and design consideration (2/3)

- ✓ While working memory and semantic memory are forms of retrospective memory or memory for past events, prospective memory refers to remembering to do things in the future.
 - For an event-based prospective memory task, an environmental cue reminds one to perform a prospective task.
 - Time-based tasks are largely self-initiated and require one to perform an action at a certain time or after a specified amount of time has elapsed.
 - Age differences in prospective memory are usually much greater for time-based than event-based tasks [Park et al., 1997] .

→ Design consideration

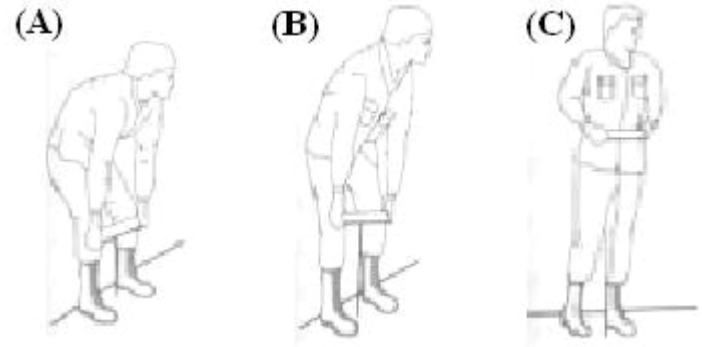
- ✓ By including environmental support in the form of a reminder or cue that is specific to the task, time-based tasks can be transformed into event-base tasks.
- ✓ Because prospective memory tasks have a retrospective component (i.e., remembering what to do) and a prospective component (i.e., remembering when to do it), an effective intervention must support both.

Difficulties due to cognitive aging and design consideration (3/3)

- ✓ The term “spatial ability” refers to one’s general ability to mentally manipulate images or patterns, for example, determining how to manipulate furniture so that it may pass through a door frame.
- ✓ Of particular interest here is the strong relationship between spatial abilities and older adults’ computer-based task performance that require high spatial ability such as navigating through a web site.
- ✓ Selective attention is the cognitive mechanism used to filter out irrelevant information thereby allowing relevant information to be processed in memory.
- ✓ Reading a book in a noisy café illustrate one application of selective attention. Driving an automobile is another task that is highly dependent on selective attention.
- ✓ Age differences in selective attention are task specific to the extent that semantic knowledge relevant to the task can be applied.

Human Muscle Output

- ✓ Our ability to apply a force or torque depends on a number of muscle strength factors, including whether we are sitting, standing, or lying down, and the direction and duration of the force.



(A)

Force	5 th percentile		95 th percentile	
Average(N)	737.5	330.9	1354.5	817.6
Maximum(N)	844.7	396.9	1437.2	888.3

(B)

Force	5 th percentile		95 th percentile	
Average(N)	758.0	326.1	1341.6	840.7
Maximum(N)	830.9	374.1	1441.7	905.2

(C)

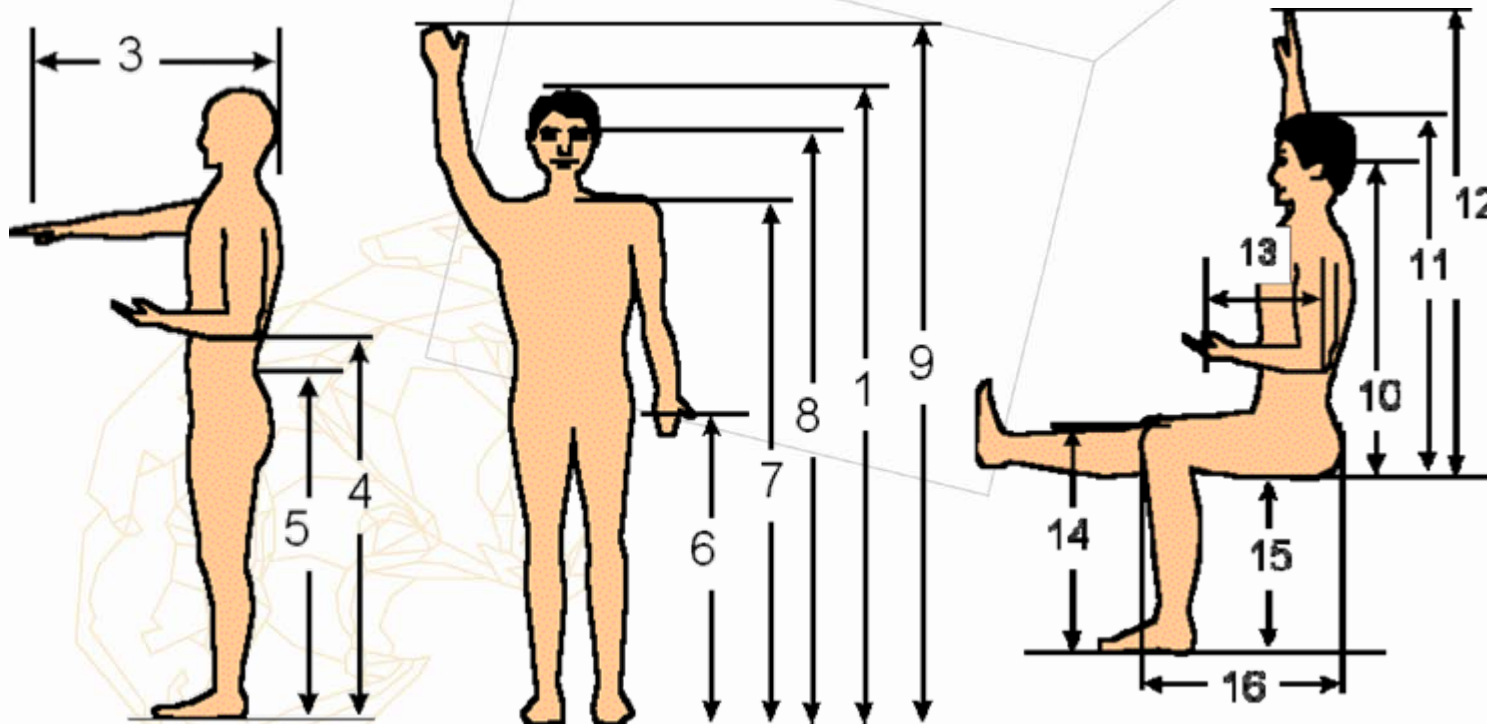
Force	5 th percentile		95 th percentile	
Average(N)	444.4	185.0	931.0	443.0
Maximum(N)	504.0	218.0	988.4	493.3

Age-related decline in movement

- ✓ Age-related changes in muscle composition and activation are important determinants of difficulties with motor control. All types of muscle fibers decrease with age, but the reductions are most pronounced for fast-switch fibers. There is also a loss and reorganization of motor units that reduces the smoothness and coordination of movements.
- ✓ As might be expected, movement time, the interval between the initiation and ending of movement, increase for a variety of point-to-point and continuous movements, particularly large movements.
- ✓ Forces used to move are more “jumpy”, peak velocity is lower, and the deceleration phase, where corrective action can be taken, is disproportionately lengthened.

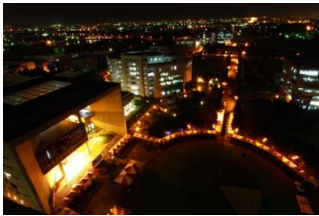
Physical Size Limitations

- ✓ **Anthropometrics** is a field of human factors that deals with the measurements of the human form such as height and reach.
- ✓ Designing for fit: design for extreme case, close fit, design for adjustability.





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Thank You

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