

ERGONOMICS AND TOOL DESIGN

'Ergonomics' is derived from the Greek word "ergon", meaning 'work' and 'nomos', meaning 'law', or 'custom'. The field of ergonomics began in Poland more than a century ago as a science to reduce industrial injuries. However the principles of ergonomic design apply not only to industry and commerce, but also to all activities of daily living, basic as well as instrumental. As Dul and Weerdmeester state in their excellent reference guide: "...ergonomics aims to design appliances, technical systems and tasks in such a way as to improve human safety, health, comfort and performance". Effectively, this involves adapting the man-made elements (tools) needed for occupation to the biomechanics of the man. This would require that tools put the least amount of stress on the integrity of the skeletal and soft tissue structures of the user, whilst still providing the means to accomplish the goal.

In people with impaired hand function, this is even more vital as the tools must not only work for the job designed, but they must also *compensate* for the lack of normal hand function.

Normal hand function is lost not only through traumatic or repetitive stress injury, but through medical conditions resulting in associated hand problems. Hand weakness occurs through muscular degeneration in such conditions as multiple sclerosis, post-polio syndrome, and dystrophy, and also through avoidance of using the hand because of the pain of diseases such as rheumatoid arthritis. Sensory loss through conditions such as diabetes can result in the inability to feel small handles and thus the user becomes clumsy in holding mainstream tools. Impaired coordination and pronounced tremor that occurs with neurological disorders such as Parkinson's disease, can result in the inability to use "normal" utensils for self-feeding. These medical conditions and the effect on hand function can result in social withdrawal, depression and loss of self-esteem. Good ergonomic tool design to compensate for the effects of these conditions and associated hand problems, impacts not only the physical but also the psychological well being of the user.

Blair et al point to the following in effective ergonomic tool design:

1. The tool should be designed for operation with a straight wrist: the tool should be bent, not the wrist.
2. Tools should be light, and heavy tools should be suspended or counterbalanced.
3. The grip span of a one-hand tool is best at about 2" and should not exceed 4".
4. The handle surface should be shaped as to contact the largest possible surface of the inner hand and fingers, thereby distributing forces evenly to resist creation of pressure points.

Established anatomy and biomechanical principles assert that in using tools it is important for the hand and wrist to be in a neutral position. Neutral or resting hand position is with the wrist between 12 degrees and 20 degrees of dorsiflexion. Parker and Imbus (1992) stress the importance of avoiding extreme wrist postures, which they define as ulnar deviation greater than 45 degrees from neutral, any amount of radial deviation; palmar flexion greater than 30 degrees and dorsiflexion greater than 15 degrees from neutral.

The weight of the tool is important, as is the comfort of the feel of the handle. The handgrips should be wide and long enough as to increase the contact surface with the hand, and to be slightly convex (Dul and Weerdmeester). A larger contact surface with the hand aids those suffering sensory loss, and gives added control to those with weakness. By compressing padded or slightly cushioned handles, a degree of control can be achieved by those with tremor.

Tools should be sharp, as blunt tools need greater force to use and may slip in a weak hand, so the quality of the blades or prongs is a vitally important factor.

In conclusion, ergonomically designed tools should be of high quality, and lightweight. The handles should be of the correct size to allow control and comfort: the tool should be bent, not the wrist, and the tools should be sharp so as to use less energy and be less likely to slip. All of these factors should be considered when choosing or recommending the best adaptive tools.

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