THE EFFECT OF WORKGLOVES ON MANUAL DEXTERITY

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by

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I. INTRODUCTION

Workgloves have established themselves as an important part of the workplace due to expanding awareness by management of the detrimental effects of the costs of accidents caused by chemical exposures and traumatic injuries. The selection of workplace gloves is based primarily on the protection afforded by the material of which the glove is made as it relates to the hazard one seeks to avoid, the purchase price, availability, durability, etc. Comfort of the employee is rarely considered as a primary selection factor, nor is the effect of a glove upon the manual or digital dexterity of a worker considered in most cases.

The purpose of this paper is to determine if gloves affect finger and hand dexterity and to associate dexterity reduction factors with gloves of varying materials and thickness to provide additional selection criteria for the person responsible for the purchasing of gloves. Such factors may also be useful in the modification of allocated times for various motions as defined by Predetermined Time Systems (PTS) such as Methods-Time-Measurement (MTM).

To begin, a history of workgloves and generally accepted methods of selection will be discussed. Gloves

will be categorized into distinct groups, with representatives of each group chosen for this study. State-of-the-art techniques of dexterity testing will be discussed along with a specific method chosen for this investigation. Then, the method of experimental design will be addressed to assist in the development of an experiment that will produce accurate and repeatable results with a minimal amount of time expenditure by the test subjects. A format for the recording of experimental results will be developed to record information of the test subject, glove data, and associated times for the task performed. The results of the experimentation will be compiled into a usable format and discussed in the conclusion. Finally, recommendations for further study will be discussed at the end of this report.

II. HISTORY, MANUFACTURING, AND APPLICATION SELECTION OF WORKGLOVES

Gloves reach back far into history; the excavation of King Tut's tomb conducted in 1922 unearthed the discovery of a rather well-made pair of linen gloves. The making of gloves during the Middle Ages was a tedious art, where gauntlets constructed of "mail", a material consisting of numberous small metal chain links joined together in an intricate pattern, protected the hands of the knights. In the late 1880's, a housewife decided to try making mittens for her husband and sons by using bed mattress ticking along with a thin liner. The homemade mittens proved to be so practical and relatively inexpensive that the sons started a factory to mass-produce the new style mittens as an alternative to leather gloves or mittens. Historical evidence shows that leather gloves have been available for about 600 years, but the cost of leather gloves was far above the means of most people.

Gloves have been primarily constructed in the past of the materials that were readily available; the same holds true today - as new materials are developed, glove manufacturers are quick to find applications. What has not really changed very much in the course of history is the basic technique of construction and manufacturing.

Many of modern day's manufacturing techniques are merely refinements of what was done in the past.

In 1834, Xavier Jouvin of Grenoble, France invented a special cutting die that turned the art of glove making into an industry. His new cutting die allowed parts to be cut such that a glove of precise fit would be possible. Prior to his invention, each glove had to be hand-knitted. The hand-knitted process produced unique gloves, no two of which were identical. [(1)]

Improvement upon Mr. Jouvin's cutting die was made by the sons of the aforementioned housewife, Lou and George Clausing. Fifty years after the Jouvier invention, these brothers designed a special die that would allow the cutting of holes to facilitate the application of separately applied thumbs. Additionally, their new process allowed many pairs of gloves to be cut at the same time. These advantages enabled the brothers to build a production line style factory employing 25 persons in what was one of the first glove manufacturing companies.[(2)]

The difficulty in glove manufacturing lies in the fact that a glove must be made three-dimensionally such that it does not inhibit the performance of the human hand, which is perhaps the most complicated mechanical device of the body. Protection against various hazards

such as cold, cuts, chemicals, etc. must be afforded while still allowing the hand to perform with tactile and dexterity sensitivity. Employees work primarily with their hands and minds. With this in mind, workgloves are a critical part of the employee's wardrobe.

Leather gloves usually consist of eight components. These components are: a one-piece palm and back, thumb, three forks or slender leather pieces that form the sides of the fingers that are called "fourchettes" by the industry, and three diamond shaped pieces of leather which are sewn into the area where the fingers join and are commonly called "quirks" by workglove manufacturers. These glove parts are primarily cut with the use of a sharp weighted steel die; on occasion, shears are used to cut parts.(3)

Problems abound in glove production due to the two following factors. As mentioned previously, gloves must be designed "three-dimensionally". Due to the shape of the human hands, gloves are not constructed symmetrically as are many other garments. Also, the stitching for the gloves is done on the inside of the glove. If the stitching were done externally, gloves life expectancy would be greatly reduced because the threads would be openly exposed to abrasives causing thread failure, allowing the seams to separate. Keeping these difficul-

ties in mind, it is not surprising that training times for glove sewers are high. 700 to 800 hours of training are generally required to train a sewer of cotton gloves, 1,000 hours for a leather palm glove, and approximately 1,200 hours for the sewer of a full leather glove.(4)

The glove manufacturing industry is currently moving ahead in areas such as: automatic sewing machines, new cutting techniques and machines, and the introduction of numerous new materials. Notable strides have been made in the area of materials, primarily due to synthetic fibers used alone or in combination with cotton. Some progress has been made in the area of developing synthetic leathers; however, none of the synthetic leathers have yet to demonstrate the properties that make natural leather one of the best protectors for the hand. One recently developed material called "Gore-Tex Barrier", manufactured by W. L. Gore and Associates of Elkton, Maryland, is being incorporated into workgloves. The uniqueness of this material lies in the presence of about nine billion microscopic pores per square inch of material. Since each pore is roughly 1/20,000th of the size of a drop of water, it is liquid water proof. Pores 700 times larger than a molecule of water vapor allow vapor to pass through the material. This ability enables the material to

"breath". The properties of "Gore-Tex Barrier" make it extremely desirable for work applications where high temperatures are involved where a worker must be able to eliminate perspiration, such as a firefighter wearing gloves. Besides the glove industry, this material has found applications in apparel and tents for outdoorsmen and in medical vascular grafts. (5) With increasing awareness of the deleterious effect of chemicals in the workplace, great progress has been made in the manufacturing of dipped gloves made from substances such as: latex, polyvinyl chloride, neoprene, urethane, and nitrile rubbers.

For practical purposes, gloves can be classified as "job-rated" or "general purpose". Job-rated gloves are those types of workgloves designed to protect the worker from the peculiar hazards of a job. An example of job-rated gloves would be the stainless steel mesh gloves used by those engaged in the cutting of fabrics in the garment industry. General purpose gloves are intended to afford protection against a number of hazards; however, protection against all hazards can not be incorporated into a single glove type.

Some examples of job-rated gloves would include: the aforementioned stainless steel mesh glove, electric

utility lineman's gloves, heated gloves used in extremely cold environments, leaded materials used to shield workers from radioactive sources, and specific materials used for protection against the myriad of chemicals in the workplace. For example, rubber, neoprene, and vinyl are good protection against corrosive chemicals. For the handling of petroleum products, neoprene and vinyl are appropriate. Neoprene is useful for the handling of most solvents, oils, and aliphatic hydrocarbons, but can not be relied upon for the handling of aromatic and halogenated hydrocarbons, ketones, and several other solvents. The presence of the various chemicals dictates proper selection of gloves for a work task, a job usually delegated to the glove manufacturer. Chemical handling gloves become further job-rated when one contemplates other variables such as: resistance to abrasion and puncture, flexibility, and tactile properties.

Some of the more common glove types that could be considered to be general purpose are: terry cloth, various leathers, the synthetic fiber aramid which is trademarked as "Kelvar", and cloth impregnated with various types of rubber. Gloves made from terry cloth of the aramid fiber offer heat-resistance of up to 1,000 F, "superior" resistance to cuts and abrasion, and are light-