

“Ergonomic design of CNC machine for disabled operators”

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Abstract

Various surveys have showed that most people with disability need equal work opportunity, while those with special requirement needs special accommodations. Meanwhile, manpower shortage is becoming more serious in present manufacturing industry and there is less labor work involved in CNC machine operation. Thus, it is a good opportunity for disable people to work in manufacturing industry as CNC operators. In the preliminary research, planned to conduct observation and interview to understand activities of CNC operators with disabilities and to identify the critical factors for developing new design of CNC. We choose VMC (Vertical Machining Centre is a type of CNC machine) for our study because it having some special ergonomically suitable accommodations suited for disabled operators. But operator's performance restricts by the poor design of the machines and the work volume as a result, many people, especially wheelchair users faces barrier for employment opportunities in the various manufacturing industry. To address this problem, on which we will study the workability of a current VMC design and modification. This study also collected data for universal VMC design based on this usability research, the concepts of VMC arthrometric design scenarios were developed and later the concepts will be evaluated. VMC arthrometric design scenarios evaluation will help to develop the new design for wheel chair operators. This study addresses limitations of wheelchair users with respect to CNC without Vertical Machining Centre operation, especially machining Centre, material loading and control panel reaching issues. This study will collect the data about user needs and preferred VMC settings for all users - wheelchair users and people without disabilities. Then, design guidelines will be developed so new design can develop and improve current designs of available VMC for improved safety and performance; re-conceptualize totally new designs of VMC through work reorganization offers very high level of safety and ease of operation for all users. The guidelines will increase direct design attention for modification and produce better designs of VMC and in turn the new machines will offer greater opportunities for employing wheelchair users alongside people without disabilities in the manufacturing industry.

INTRODUCTION

Modern Manufacturing has passed through a amazing deal of trade due to world opposition and swiftly exchange due to purchaser expectations. To expand productivity, producers are more and more relying on high-quality and environment friendly equipment (Yan, 2003). One such device is Advanced Manufacturing Technology (AMT), and a extensively used instance is CNC machine. The CNC computer stands for Computer Numerical Controlled Machine. A pc that reads guidelines generated via a processor and drives a powered mechanical gadget normally used to fabricate components by way of putting off fabric (Madison, 1996). The introduction of CNC machines into manufacturing enterprise essentially modified the work fashion and facilitated the operations; for example, the CNC machines make it handy to reduce curves as straight traces and produce complicated three-D structures, for this reason dramatically lowering the range of machining steps that required human motion (“CNC,” n.d.).

1. Manufacturing jobs are changing at the same time as the manufacturing workforce is

changing. The U.S is staring right in the face of a severe worker shortage as 77 million baby boomers prepare to retire in the next few years— with a fewer number of younger workers available to replace them. (U.S. Chamber of Commerce, 2006, p13). In a study funded by the National Association of Manufacturers(Eisen, 2003) more than 80 percent of the large and small. “Moderate to serious” shortage of qualified job applicants, and forecasts predict a need for 10 million skilled workers by 2020 (National Association of Manufacturing, 2003)

2. The best way to address this shortage of manufacturing workers is to hire people with disabilities. They represent a potentially large pool of workers. According to 1994–95 data from the National Health Interview Survey on Disability, 82.6% (489,000) of working-age wheelchair users are not in the labor force (Kaye et al, 2002). The societal trends have also changed from a medical model emphasizing a clinic approach to "fixing" or "curing" people with disabilities to the present emphasis on capabilities, choice, and workplace supports in maximizing the work potential of people with disabilities. (Unger, 2002). People with disabilities can use machines more effectively by enhancing job accommodations, according to previous studies (Phillips et al, 1997). However, wheelchair users are rarely employed as CNC machine operators in manufacturing environments.

LITERATURE REVIEW

Over half of the people with disabilities interviewed reported that they wanted to obtain a better job in the near future (Govt. of India Census of disabled people, 2011). According to Rehabilitation Research and Training Centre on Disability Demographics and Statistics (2004), in the year 2004, only 22.4% of working age people with work disabilities worked full time full year Because of their low employment rate, people with disabilities are more likely to be poor than those without disabilities. Within the working-age population (16-64), 30% of people with work disabilities live below the poverty level [15]. A series of studies conducted by the National Organization on disability and [9] found that an overwhelming majority (72%) of unemployed persons with disabilities indicated that they preferred to work “Putting people with disabilities back to work, or enabling them to remain at their jobs following onset of a disability, is one of the key elements of International disability policy”.

ADVANTAGS

- 1.Preliminary study: Use previously published research, and conduct interview and observation to define the need for CNC machine operators
- 2.Mathematical Modelling: Mathematical modelling of collected data
- 3.Works Space and design analysis: Use Artificial Neural Network (ANN) for Modelling & Simulation
- 4.Laboratory simulations: Evaluate existing machine to find out what are the barriers for operators using wheelchair
- 5.Design scenario evaluation: Evaluate two scenarios that utilize design and future technologies to develop a safe and efficient VMC machine for wheelchair users and other people.
- 6.Provide design guidelines for CNC machine manufacturing.

LIMITATIONS

- 1.The next step of this study is to make a full-size mock-up of design scenario 1, recruit more subjects using wheelchair and able-bodied operators with CNC operationalexperience, use the same method in chapter 5, to improve the design.
- 2.Wheelchair user is a group of people with disability. Universal design of the CNCmachine should be able to accommodate wider range of people with disability. For example, next step of testing can involve people with vision impairment.
- 3.Additionally, helping CNC machine designers, developers and CNC machine manufacturers understand the benefits of universal CNC machine design, and testing thedesign guideline between them are also important work in the future.

RESEARCH SCOPE

Metalworking

Metalworking is the craft and practice of working with metals to create individual parts, assemblies, or large-scale structures. Originally, CNC will be applied to metalworking machinery, and now the CNC machines

are still mainly used for metalworking [11]. Industries relate to metalworking like working with big sheets of wood or steel, working with small-scale metal products requires less physical effort. Thus, these types of jobs might be easier for the wheelchair users to perform.



Vertical Machining Centre (VMC)

The Vertical Machining Centre is one of the most popular CNC machines. It provides a wide power range for metalworking flexibility. Vertical Machining Centre is deal for mould/die and other mid-range parts producers. It is advantage including:

1. High level of automatic
2. Combine multifunction
3. Use for materials besides metal, (e.g. plastic)

VMC are being used in medical, mold /die, automotive, aerospace, heavy equipment and many other dynamic industries.

Wheel chair users

An estimated there are over 27 million (2.7 Crore) people with disabilities out of which 5.4 million or 54 lakhs (54,36,826) have disability in movement in India. Given the poverty distribution in India, only a small fraction of these have access to Wheelchairs. (Census of India 2011) Many people have mobility impairments, for example paraplegia or spinal cord injury; have to use manual or power wheelchairs. But their upper body may not be affected, and they may have good muscle strength; and have finger, shoulder, elbow and wrist extension and flexion. This group of people may have the physical ability to work as CNC operators

FUTURE SCOPE

Manufacturing industries like food, beverage, textile, apparel, wood, paper, chemicals, plastics, rubber, machinery, electronic, etc. CNC machines also have different types. Categorized by function, there are CNC routers, CNC lathes, etc. Categorized by shape, there are Vertical Machining Centers, Horizontal Machining Centers, and Table CNC machines. Different CNC machines are used in different manufacturing environments and have different requirements for the operator. People with vision impairments, hearing impairments, mobility impairments, or cognitive impairments also have different limitations. Accommodations for them are quite different. In this research we will focus will be made on designs that may lead to work opportunities for wheelchair users in the metalworking manufacturing environment using Vertical Machining Centre (VMC).

CONCLUSIONS

CNC machine widely used in manufacturing environment, the physical requirement for the machine operator

is significantly reduced. There is a potential for wheelchair user to get a job in manufacturing environment as a CNC operator, but there is no study showed that wheelchair users can work on CNC machine safely, easily, and efficiently. In a case study of VMC, barriers for wheelchair users will be identified. Loading material, changing tool, operating on the control panel, checking machined parts is most important tasks for the VMC operators, but most of these tasks are all difficult for the wheelchair users. It is the need to modify and design new adjusting the position of VMC components and increasing space for comfortable working of disabled operators as well as without disability operators.

REFERENCES

Bayo-Moriones, A., & De Cerio, J. M. (2004), Employee Involvement: Its Interaction with Advanced Manufacturing Technologies, Quality Management, and Inter-firm Collaboration. *Human Factors and Ergonomics in Manufacturing*. 14(2), 117-134

Bullinger, H.J., Warnecke, H.J. and Lentjes, H.P., 1983. Toward the Factory of the Future. *International Conference on Production Research*, 3(4), 4-11.

Campbell, J.L. (1996). The Development of Human Factors Design Guidelines, *International Journal of Industrial Ergonomics*, 18, pp363-371 CNC. (n.d). Retrieved July 1, 2008 from <http://en.wikipedia.org/wiki/CNC>

Das, B., Kozey, J., (1999). Structural Anthropometric Measurements for Wheelchair Mobile Adults. *Applied Ergonomics* 30 (5), 385–390.

Donald M. Atwater, Aisha Jones. (2004). Preparing for Future Labor Shortage, *Graziadio Business Report*, vol7, No. 2

Eisen. P. (2003). Keeping America Competitive-How a Talent Shortage Threatens U. S. Manufacturing. White paper

Frymoyer, J.W., Pope, M.H., Costanza, M.c., et al., (1980). Epidemiologic studies of low-back pain. *Spine* 5(5), pp419-423

Harris, L. & Associates. (1998). The N.O.D/Harris Survey Program on Participation and Attitudes: Survey of Americans with Disabilities. New York: Author

Haynes, S. & Endicott, S. (2005). Accommodations for Employees with Sensory Impairments in Automated Manufacturing. Retrieved from http://library.ncrtm.org/AT/RESNA_2007/Research/JEA/Haynes.html.

Kaye.S. (1996). Disability Statistics Abstract, Washington, DC: U.S. Department of Education, National Institute on Disability and Rehabilitation Research Abstracts, 20 p1.