2015 WJTA-IMCA Conference and Expo
November 2-4 • New Orleans, Louisiana

Paper

CNC WATER JET SET DESIGN FOR EDUCATIONAL PURPOSES AND ITS IMPLEMENTATION

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ABSTRACT

In today's manufacturing industry, any products are manufactured by using CNC (Computer Numerical Control) machine. CNC machine developed and sustained its improvement becoming an indispensable part of manufacturing sector. In order to educate operators that would use CNC machine which have important role for manufacturing industry; theoretical courses such as basic level machine utilization, machine programming are given at vocational schools, vocational high-schools and faculties. However; these information are not given practically in most of the educational institution. The reason for this is not being able to purchase expensive CNC machine by educational institution and maintenance services being ineffective. In this study, low-cost education set that would enable more active learning in which students who are taught CNC education can practice on their own was designed, its prototype was produced and application was done.

Keywords: Desktop CNC Machine, Educational CNC Machine Design

1. INTRODUCTION

Abrasive waterjet cutting process, as one of the non-traditional machining methods, is increasingly being preferred by the machine manufacturing industry and expanding its area of use continuously for its superiority when compared to other cutting technologies. Initially used in the mining industry, waterjet is now gained widespread use in other industries. Waterjet is categorized under two groups, namely, abrasive and pure waterjets. It is possible to cut brittle, ductile, composite and metal materials using abrasive waterjet. It is able to cut any engineering material no matter what the roughness level [1].

Abrasive waterjet cutters are of utmost importance for today's industry. Therefore, it finds its place in the curriculum of vocational high schools and faculties as a non-traditional manufacturing method. Abrasive waterjet cutting, as a non-traditional manufacturing method, has created an important employment opportunity and a new profession in the cutting industry. However, educational institutions cannot purchase costly abrasive waterjet cutters and are only able to provide theoretical information and illustrations about the operation of these machines leaving no choice for the student but to imagine an abrasive waterjet. It would be fair to say that there is almost no institution in Turkey which provide applied education with CNC waterjet. This study involves a CNC waterjet cutting machine which can be built by technical education institutions using their limited resources and its application in order to train students on basic subjects such as the workings of waterjet and cutting with waterjet as part of their non-traditional manufacturing classes. The literature scan performed in order to drive this study involved the following; Kim et al. addressed the lack of educational material in CNC education and manufactured a low-cost CNC milling machine [2]. Köbeloğlu designed an educational CNC milling machine for higher education studies and built a prototype [3]. The research of Alan lays emphasis on the CNC education in Turkey and the importance of CNC for vocational education and the industry and designed a CNC education set in order to be used in CNC classes [4]. Uyanık et al. worked on the integration of 3-axis surface milling machines with CNC [5]. Toroğlu et al. investigated the use of 3-D animation techniques to be utilized in technological education [6].

We have failed to find a study about an educational CNC waterjet suite and its prototype as a result of the literature scan. This study aims to be exemplary for institutions focusing on technical and engineering education with a CNC waterjet cutter design which is possible to build with resources readily available and it is expected to contribute to future research.

2. STRUCTURAL CHARACTERISTICS OF THE MACHINE

System was designed and put together in order to build an educational CNC waterjet. Initially, CNC vertical machining center was built using steel profiles in order to allow for computer controls on x, y, and z axes of the CNC waterjet cutter. The cutter was then welded as required using the measurements of the design.

Following the manufacturing of the frame of the cutter, the pressure unit was designed and manufactured. Industrial CNC waterjet cutters most commonly use a working pressure of 4000 bars. The pressure value was not increased as it would lead to increased costs, power consumption and safety issues when necessary measures are not taken for use with educational purposes. The operating pressure of the cutter was set to 110 bars which is sufficient for cutting process. A booster pump was used as the feed pump of the pressure unit. Water taken from

still water container of 1 bar pressure feeds the high-pressure pump. Water from feeder arriving at the high-pressure pump with a pressure of 10 bars is then conveyed to the nozzle outlet with a pressure of 110 bars. A car wash machine was purchased as an alternative solution to obtain a pressure of 110 bars and it was dismantled in order to be used in the water pump of the waterjet mechanism. Figure 1 shows the pressure unit of the industrial waterjet while Figure 2 shows the pressure pump obtained from the pressure car wash machine.

Figure 1. Industrial water jet pressure unit view.

Figure 2. The pump unit is derived from pressure washer.

The pressure unit obtained from the car wash machine and the waterjet unit built using CNC vertical machining center were then assembled.
Figure 3 shows an industrial CNC waterjet cutter while Figure 4 gives an overview of the CNC waterjet cutter built for educational purposes.

Figure 3. The view of Industrial type CNC water jet machine

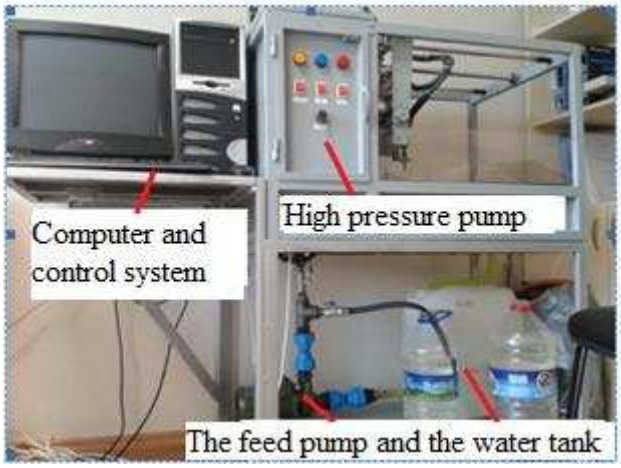

Figure 4. Educational purpose CNC water-jet bench overall image.

3. EVALUATION OF THE APPLICABILITY THE MACHINE

The prototype of educational CNC waterjet cutter was then subjected to tests and successful results were obtained. As the system was not fed with abrasive dust, it was only able to cut materials such as polystyrene. Thus, Stryrofoam insulation material was selected as the material to be cut. Drilling and cutting a workpiece made of insulation foam of 18mm thickness was successfully performed. Figure 5 shows the drilling process with waterjet while Figure 6 shows an image of the lateral view of the material being cut. Figure 7 shows the letters cut out of the styrofoam as a result of the waterjet cutting process.

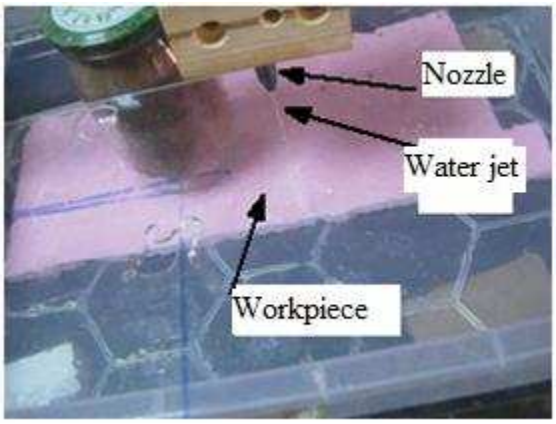

Figure 5. Drilling operation of styrofoam with the water jet

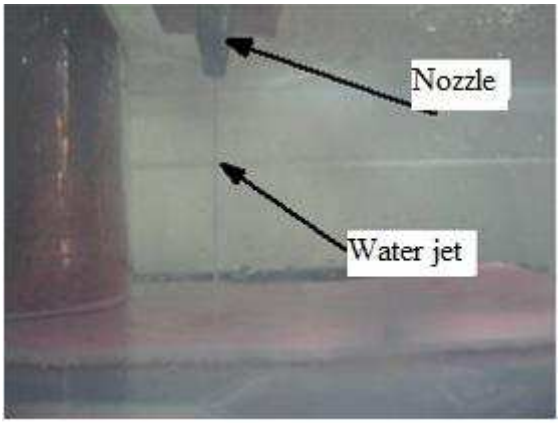

Figure 6. Side view of the styrofoam water jet drilling operation.

Figure 7. The image of the sample letters cut from styrofoam with the water jet.

4. CONCLUSION AND RECOMMENDATIONS

An educational CNC waterjet cutter was developed in this study combining a vertical machining center with a waterjet manufacturing system. The cutter involves a genuine waterjet nozzle. This design proved to be a low-cost educational set which can be manufactured by vocational high schools and faculties with readily available resources in order to be used in non-traditional manufacturing methods classes. As imported CNC waterjet cutters are expensive and it is hard to provide services for these cutters in Turkey, the educational set developed will eliminate these disadvantages. This study offers an opportunity for the students

to work on a compact and low-cost experiment set individually as part of the non-traditional manufacturing methods classes. As a result of this study a more visual and realistic education for the waterjet subject once was only available in a theoretical manner will be possible with the educational set as shown in Figure 4.

The waterjet cutter developed does not include abrasive and abrasive feeder due to safety and monetary considerations. It is possible to improve the design with the addition of abrasive mixing tube and abrasive nozzle.

5. REFERENCES

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