

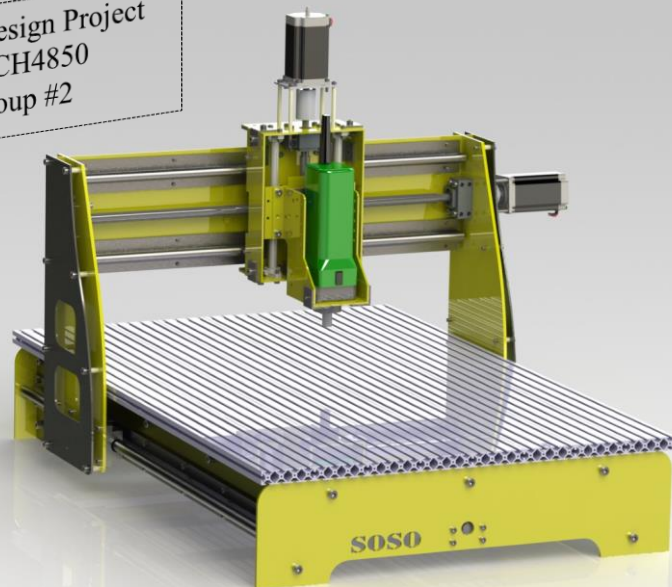
9/16/2014

JR CNC Router Table – JR, INC – Group #2

Innovative Computer Numeric
Control Machine operated by a
mechanical arm

JR

Senior Design Project
MECH4850
Group #2





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Tables

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Chapter 1: Introduction

1.0 Design Goals

The goal of this team's efforts is to develop a product that will establish *JR, Inc.* which hopes to revolutionize the market of such. Specifically, we were commissioned to design and manufacture a *CNC Router Table* that is both innovative and functional. What follows is a description of the product itself and information that helped the team to choose this specific project.

1.1 Problem Statement

After spending a long period of time researching and comparing the team's idea to the ones that are on the market, we immediately had the need to come up with solutions to certain problems encountered. One of the most significant and most drastic problem is the fact that an operator is restricted to the size (considering the width) of the material to be cut on the table. This is due to the design of such tables; which is built with symmetry. As a result, operators are restricted and obligated to use only the space that is provided by the table. The highly expensive price of such machines was another problem that was spotted. This one in specific is very significant due to the fact that it is not easily accessible to the targets; which are wood, aluminum and plastic enthusiasts, wood-workers, and so on.

1.2 Bench Marking

By measuring our product's ideas and comparing them to the competitors, we identified major differences that will be on our benefit. This is because of the act of addressing the problems found in such products. As a result, the team is very motivated to create a preliminary and innovative design and hopes to create a product that is both productive and aesthetically pleasant.

1.3 Identifying Customer Requirements and Needs

It is to be understood that customers are the lifeblood of every company. They are the main reason why products are developed in such form. The way the industry is set up, companies attempt to use the customer's need as much as possible; and as a result, they expect a profitable return. Before this, they'll need to identify and evaluate the customer requirements and needs. Hence, it was a necessity for the team to follow this procedure in order to mature our idea.

Numerous customer requirements and needs can be found for the market that is being targeted. To start, customers need to have the accessibility to purchase a quality and productive CNC Router Table. They are also in the need of the incorporation of new technology. Least but not last, customers need a more spacious table which can be used to cut larger piece of material without being restricted to the width of such.



1.3 (continuation)

In-Use Purposes and Market

The name of the product to be designed is “*JR CNC Router Table*”. The function to be performed is to cut any desired type of shape or letter by the use of the famous Computer Numeric Control system. Although that is its main purpose, such machine will carry a tremendous amount of special features that will separate it from the existing ones. Such features are as follows:

- a) One retractable mechanical arm
- b) Perforated table top to debris to fall into the integrated dust collector
- c) Inexpensive
- d) Lightweight (usage of plastic and aluminum)
- e) Integrated vacuum and blower line at the tool bit
- f) Magnetized holder to store bits
- g) Multi-size jig for operation of various tools and bit sizes
 - a. I.e., Engraving, cutting, drawing, etc.
- h) LED light at the tool bit for better visibility
- i) Anti-Vibration rubber feet (isolators)

The intended market are wood, aluminum and plastic enthusiasts, wood-workers, technical drawers, industrial designers and more. The *JR CNC Router Table* can be said to share only simple similarities to other companies' products. This is due to the impressive amount of special features that are incorporated into the machine. On the other hand, these special features do not increment the final retail price of the product by much. The estimated retail price for the *JR CNC Router Table* is about \$2,500 dollars. This is a very reasonable price because if one compares this given price to the retail price of existent similar machines, one will see a huge difference which is why customers cannot purchase such machines.

Functional Requirements

The following are information and approximations of the dimensions that will be found on the *JR CNC Router Table*;

- Size of table: 2' x 2'
- Thickness: 3 inches.
- Overall weight: 20lbs
- Shape: Square
- Surface finish: Anodized aluminum coating or powder coated

Other than designing and manufacturing this product, *JR, Inc* will also create a customer service line with the intention to help our future customers the best way possible.



1.3 (continuation) Corporate constraints

Due to the seriousness of the customer need to be able to purchase a CNC machine, the time to design, manufacture and do the marketing is very limited. In addition, there are manufacturing requirements that need to be followed in order to give a final product which will exhibit and ensure top quality. For example, the team needs to manufacture an aluminum table top which will be perforated around the whole area. Also, to manufacture and assembly the frame of the machine table can require a lot of time. But, due to the team's optimism and determination, we are more than sure that we will complete this project within two months. It is important to mention the financial aspect as well. We are constraint to an approximate of *\$250 dollars* which was donated to us in order to help the project get started. But, aside from this money, the team will collect money from each other in order to accomplish our goals. Also, since the team members work in the construction and gear production' area, it will be easy for us to bring any material at a very cheap price.

Social, Political, and Legal Requirements

It is to be understood that Social, Political, and Legal requirements are a very important aspect when designing or manufacturing a product. It plays a very important role, which should be taken care very seriously because the success of your company are dependent on a large scale to these requirements. Similar to every product that is on the market, *JR, Inc.* will follow every single regulation and requirements. This will help us be more protected and assure that we will not have any future issues pertaining to lawsuits and so on.

The team will make sure to complete all the legal requirements. We will post safety images on the machine that will be highly visible. In addition, we will supply our customers with an operation and safety manual in order to decrease the chance of injuries. Also, the *JR CNC Router Table* will have a *one year warranty* and an unlimited time *24-hours* customer service.

Evaluating Customer Requirements and Needs

After spending a long period of time evaluating customer requirements and needs, the *JR, Inc.*' team is very enthusiastic to start the project and work towards the completion of such. It is very likely that one will see a very high profitable return due to this innovative idea and also because problems that were spotted during the research time are being addressed in the best possible form. Customer satisfaction is our priority and we won't rest until they appreciate our effort to make an easily accessible CNC Machine.

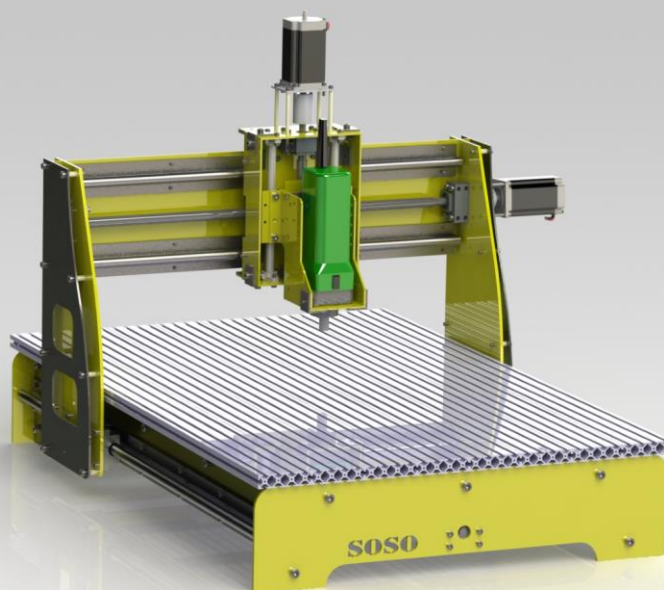


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Chapter 2



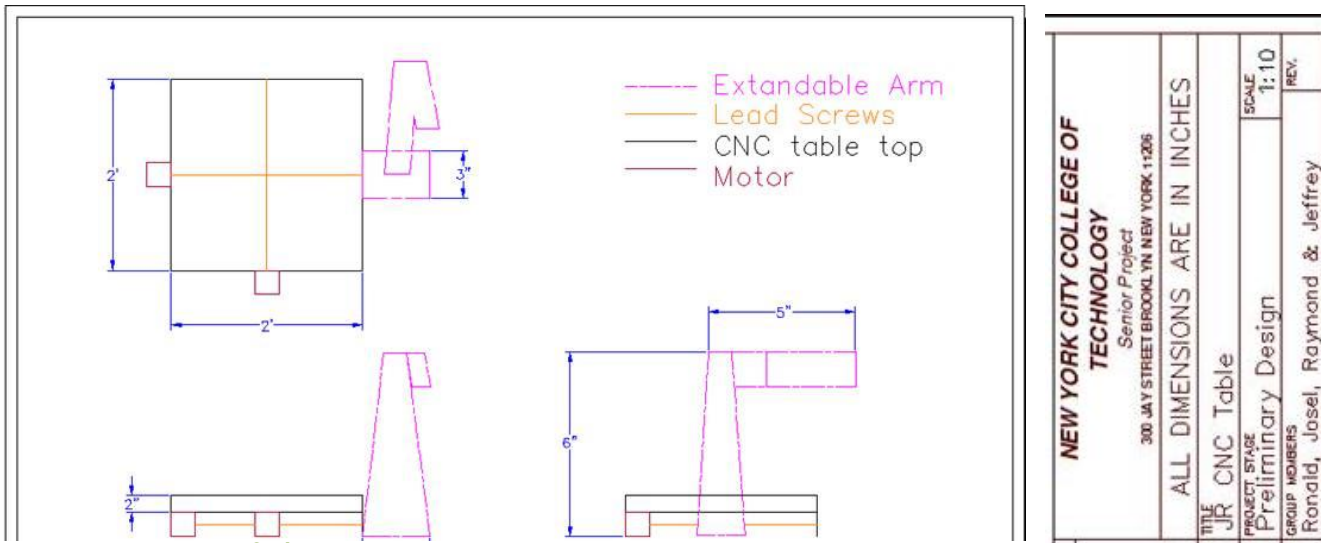


Chapter 2: Proposal

The following image is a sketch of the JR CNC Router Table

2.0 Sketch

Figure 2



2.1 Description of the operation

The JR CNC Router Table will operate using a 120v line but the function of such will be outstanding. By using this innovative router table, one will be able to perform cut, engrave or even draw any desired shape or letter in the most accurate and simplistic way; which is by the use of the famous Computer Numeric Control system.

2.2 List of materials and cost

Figure 1

PRODUCT PRICE LIST

Product list to be used in order to create the JR CNC Router Table

UNITS	NAME	Description	PRICE/UNIT	TOTAL
3	Motors	For the table	\$30.00	\$90.00
1	Shaft	6" shaft	\$20.00	\$20.00
4	Spur gear		\$30.00	\$120.00
1	Joint	For arm	\$15.00	\$15.00
4'x4'	Aluminum table	Perforated	\$50.00	\$50.00
1	Vacuum/Blower motor		\$30.00	\$30.00
2	Plastic lines	For vacuum and blower	\$10.00	\$20.00
2	Fine pitch lead screws		\$20.00	\$40.00
2	Pillow block bearing	End type	\$10.00	\$20.00
1	Magnet	For holding tool bits	\$10.00	\$10.00
1	Swtich	Illuminated switch	\$15.00	\$15.00
4	Rubber feet	Anti-vibration	\$15.00	\$60.00
1	LED Bulb	Small	\$15.00	\$15.00
1	Plastic container	For debris collection	\$15.00	\$15.00
1	Pack of wires	For electrical components	\$35.00	\$35.00
			Total	\$555.00



2.3 Review of the marketing and technical assessment

Before the team came into an agreement to proceed with this prestigious project, a lot of research and analysis was done. A summary of such analyses are as follows:

- **Market Analysis:** Due to the fact that these machines are a one-time-buy only, the complexity of creating one and how recent they are, they are priced very high. As a result, companies that design and manufacture this machines, tend not to sell a lot of them. On the other hand, there are a lot of people who would like to buy one but cannot afford it. Therefore, the team decided to make an inexpensive one but yet one that makes a difference.
- **Specifications:** CNC Router tables are able to handle various routers with different HP (horse power); but this depends on the structure of such and in the motors that are used. But, the most common router HP that a CNC Machine can take is approximately 3.5HP which has the ability to do a very outstanding performance.
- **Functional Analysis:** The functionality of the existent CNC Router table meet the requirements but lack of a very important factor which is space. Operators with such Router tables are limited to the size of the materials to cut due to how the machine is built.

2.4 Necessary key tasks to develop design

The process of developing the design of the *JR CNC Router Table* was a bit challenging and time consuming. Similar to any other concept or existing product, our design was inspired by comparing it to other designs and trying to give it a different approach. It is to be acknowledged that our experiences, passion, creativity and intelligence influenced a lot as well. We created many sketches with the intention to evaluate them to pick one or mix the possible winners. Throughout this process, the team encountered some barriers that needed to be faced in the most positive way and attempt to overcome them. For example, the fact that the structure of every CNC Router Table in the market was built in similar ways affected us by doubting if our concept will work or not. Also, the team acknowledged that a very challenging part to be faced was the programming part; since none of us have experience in that field. Least but not last, a necessary key task that helped to develop the design was by thinking about customer needs. This helped in a tremendous way and because of this, we incorporated special features on the *JR CNC Router Table* in order to address the customer needs.



2.5 Timeline

- Week 1-3: Sketch and design of the CNC router table

Create a list of parts needed with its cost. Then breakdown each part of the CNC router into components of design (arm, base, table, etc.) for calculations and refinement. During this time, the group will come up with an ideal of the model to make and create a close sketch to what is expected. Furthermore, the team will make changes to the ideal to better suit customer needs as well as making it practical and doable.

- Week 4-5: Calculations and refining the design of the CNC router

During these two weeks, the group will take each component of the CNC router and run simulation testes on the components to make sure everything is safe and functional to be incorporated into the design of our CNC router. Once each part passes the tests, the group will then continue with the refinement of the design to produce our final sketch and design of the project.

- Week 6-7: Construct the Base for the CNC router

It will take the group approximately two weeks to put the base of the CNC table together. Also, it will give us a chance to make any necessary adjustments to the design or base if needed

- Week 8-11: Assembly of the Mechanical Arm and testing motors

Three weeks will be spent on assembling the mechanical arm and making sure each motor works for the specific direction it should travel in. This is a vital part of our CNC router, so testing and adjusting is critical during these weeks.

- Week 12-14: Computer programming

Our group will have to use the remaining few weeks to write the programming codes for the CNC router. It's a very tedious task but crucial since the codes are the brains of our CNC router; which is responsible for carrying out the commands that are inputted into the computer.

- Week 15: Final Presentation

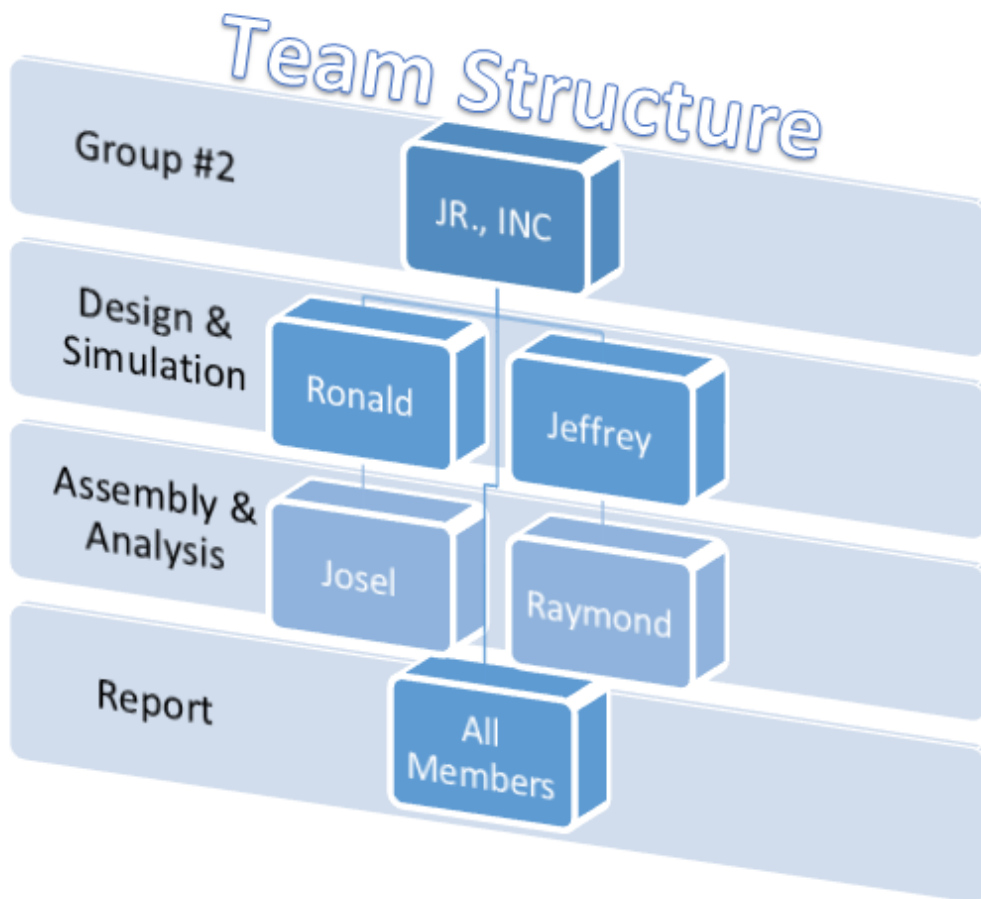
If all goes well, the team should be able to present the finish product to the class. The final design (CAD) and the physical assembly should be presented along with a final report.



2.6 Team Structure and Resource Management

The team came into an agreement to work together towards the completion of the project. As a result, the structure of the team is very simplistic. It is one where there is no “overhead”. All members of the team (*Ronald, Jeffrey, Josel and Raymond*) are committed and responsible to collaborate and help each other out as much as possible. By doing so, the necessary steps and/or tasks that need to be done will be done in a much faster and easier form.

Figure 3



2.7 List of Specifications

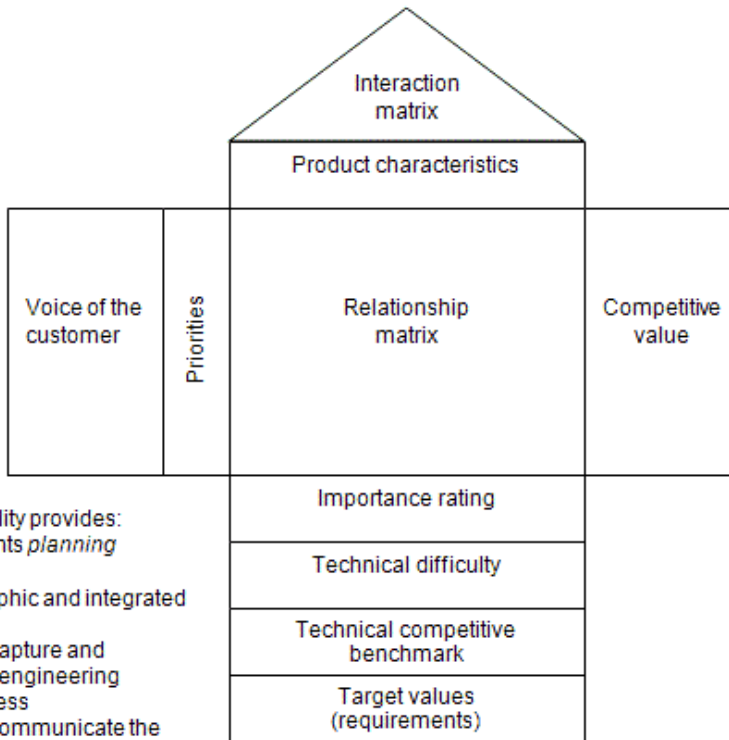
- Teknic Servo Motors (for precise motion)
- MC901 Nylon for table frame
- 6061 Aluminum alloy posts for corners with threaded bottoms and perforated sheet for table top
- Module 0.5 / injection molded Acetal gears
- Precision chrome steel shaft for guide rails
- End-support pillow block bearings for each lead screw
- Self-lubricating flanged bronze sleeve bushings for shafts
- Composite material for the arm structure and counter-weights



2.8 QFD (Quality Function Deployment)

Figure 4

House of quality template and benefits



The house of quality provides:

- A requirements *planning* capability
- A tool for graphic and integrated thinking
- A means to capture and preserve the engineering thought process
- A means to communicate the thought process to new members of the QFD team
- A means to inform management regarding inconsistencies between requirements, risks, and needs of the customer

2.9 Comments on the specifications

Specifications that will need more development will be announced as soon as we start building the physical model

2.10 Data sources

- “Burn Tables” – Link: <http://burntables.com/cnc-router-table/>
- “Instructables” – Link: <http://www.instructables.com/id/Building-a-CNC-router/>
- “CNC Router Parts” – Link: <http://www.cncrouterparts.com/>
- “BuildYourCNC” – Link: <https://www.buildyourcnc.com/>