



1.3 Functional Decomposition

The functional decomposition serves to break down the entire system into the smallest components in order to determine the basic functions. In doing so, it will take a complex machine, like a CNC machine, and make them into something more simple and easy to understand. This will involve breaking down the entire machine into its main subsystems and then further down to the component level. After using the data gathered from the I-Corps interviews, the personas, and conversations with Dr. McConomy, the team was able to break down the key functions and the systems required to accomplish them.

1.3.1 Discussion of Data Generation.

Data that was gathered during the customer needs process were analyzed to form functions for this functional decomposition. These are used to evaluate the best fit of ideas to the key goals of this project. This data was primarily gathered from conversations with the project adviser, Dr. McConomy. Each function begins with a basic verb that describes a physical, quantifiable characteristic of the system. The results are summarized in the hierarchy chart and cross-reference table.

1.3.2 Hierarchy Chart.

The hierarchy chart below was made based on the data collected from the personas, I-Corps interviews, and Dr. McConomy. The chart begins with the project objective and breaks down to the more specific, individual functions needed to complete the main objective. This is a summary of a more detailed chart that can be found in Appendix H.

Table 3: Hierarchy Table



Device	Major Function	Minor Function
CNC Machine	Structure	Controls Vibration
		Maintains axial stability/rigidity
		Holds all machine components
		Holds workpiece securely
	Movement	Keeps tolerance
		Accelerates to position
		Stops at position
		Decelerates to stop
	Safety	Access to emergency stop
		Encloses machine
	Operating system	Recognizes position
		Controls positional movement
		Controls cutting speed/force
		Controls internal temperature



1.3.3 Discussion.

By determining the most important descriptors, the team was able to break down the critical functions of the machine, as well as the more specific ones as well. Instead of explicitly naming these different subsystems, instead using verbs to describe the processes, will help to keep the design elements more open ended during the design process. From this, breaking down the different systems will help define the main categories that will be focused on in the development process.

1.3.4 Functional Relationship.

The main systems of the machine were broken down into the four main subsystems of the structure and frame of the machine, the movement system, the general user safety, and the programming and operating system. From these, the team was able to break the systems down to the secondary ones as follows; The machine will control all vibrations acting on the system, it will maintain axial stability and rigidity, hold all necessary components, have very low tolerances, high accuracy, accelerate, decelerate, and stop at the exact point, have a full enclosure, and be able to recognize where the tool is located in the system. Now that these were established, it allows for the subsystem functions to be related to each of the major systems in the machine, and this is what is seen down in Table 4 below.

Table 4: Functional Decomposition

Function	Structure	Movement	Safety	Operating System	Total:
Controls Vibration	x	x			2
Maintains axial	x	x	x		3



stability/rigidity					
Holds all machine components	x				1
Holds workpiece securely	x	x	x		3
Keeps tolerance	x	x		x	3
Provides Accuracy	x	x		x	3
Accelerates to position		x		x	2
Stops at position		x		x	2
Decelerates to stop		x		x	2
Access to emergency stop	x		x		2
Encloses machine	x		x		2
Recognizes position		x		x	2
Controls positional movement	x	x		x	3
Controls cutting speed/force	x	x	x	x	4
Controls internal temperature			x	x	2