Alquist 3D:
Building Our Future

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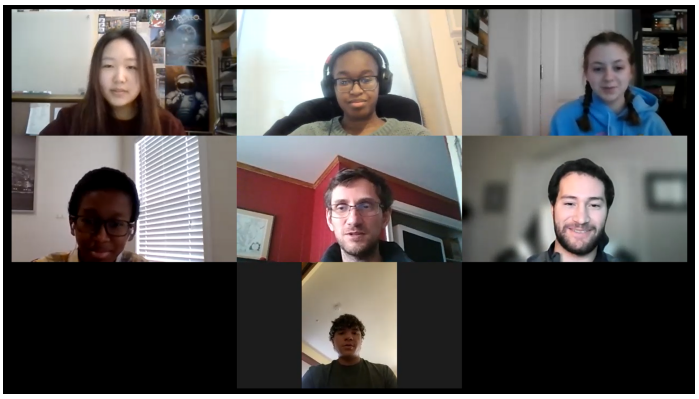
01 | Introduction

The development of 3D printers has enabled professionals and hobbyists alike to create with ease, opening up a myriad of possibilities for the future. An increasing number of companies are implementing 3D printing to solve real-world problems, one of which is Alquist 3D. Our team initially heard of Alquist from our coach, who saw their work and its benefit to communities. After researching more about the organization, we chose them for this challenge because they utilize 3D printing technology to create low-cost housing. We felt connected to the company because they were making a change near us, as we are a robotics team based in Virginia. Learning about Alquist's vision has opened up ideas to how VEX can prepare us for making a difference in our community.

Currently, many rural communities are facing housing shortages due to a lack of adequate funding. Alquist 3D's solution is using 3D printing technology to build housing, which is cheaper than traditional construction methods (Alquist). In Williamsburg, Virginia, Alquist and Habitat for Humanity partnered to create the first occupied home built entirely using 3D printing technology in the US for April Stringfield and her son (Bohon). Alquist hopes to improve their process in order to make more cost-effective and environmentally-conscious homes, transforming neighborhoods and lives.

Alquist CEO Zachary Mannheimer with April Stringfield and her son (Alquist)



Our team during our online interview with Aaron (2nd row, center) and Aiman (2nd row, right) of Alquist

Our team spoke with Aiman Hussein, director of printing technologies, and Aaron Hackett, materials director, to learn about the process used to design and construct Alquist's buildings.

02 | Design Process

From watching the VEX game reveal at the start of the season to competing at competitions, our team strives to create the most efficient design of our robot. This endeavor can only be achieved through months of brainstorming, building, and testing. Below details the design process that we follow throughout the season:

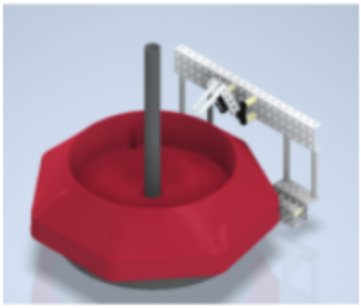
Stage	Description
Problem Definition	Recognition and analysis of the problem
Brainstorming	Formulation of ideas to reach a solution through sketches/CAD
Prototyping	Initial attempt at building
Building	Rebuilding prototype to eliminate flaws
Testing	Testing design through trials, evaluating what needs to be changed
Revising	Iterating design based on testing notes
Finalizing	Finalizing to reach a competition-ready robot

Alquist 3D printing process using concrete layers (Alquist)

Brainstorming, Prototyping, and Building: Through our interview with Alquist, we noted many similarities in how a project comes to life. When designing a Habitat for Humanity House, they begin with brainstorming – either on paper to lay down the initial idea or using CAD software (Autodesk Revit), helping designers visualize the house. Next, the model is exported to a slicing software called Rhino which converts the model of the house into a *.gcode* file that a 3D printer can

read. Similar to the slicing software of desktop 3D printers, Rhino slices the 3D model into different cross-sectional layers. The machine itself runs on an XYZ plane so after completing one layer, it rises in the Z plane to print the next.

During our team's brainstorming process, we also use a combination of brainstorming on paper and in Autodesk Inventor. For some parts, it is easier to brainstorm using paper, especially when an idea is not completely developed. For other aspects of our robot, brainstorming using Autodesk Inventor helps provide a more realistic prototype than on paper. Similar to Alquist, after the brainstorming process, we begin to physically build these designs.

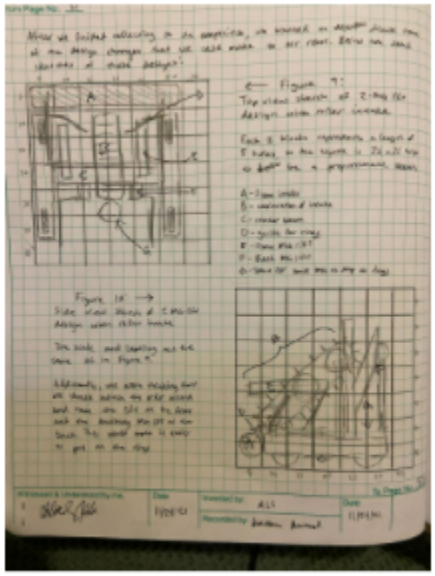


Autodesk Inventor design of a mechanism to pick up Mobile Goals

Physical prototype of mechanism.

Testing, Revising, and Finalizing:

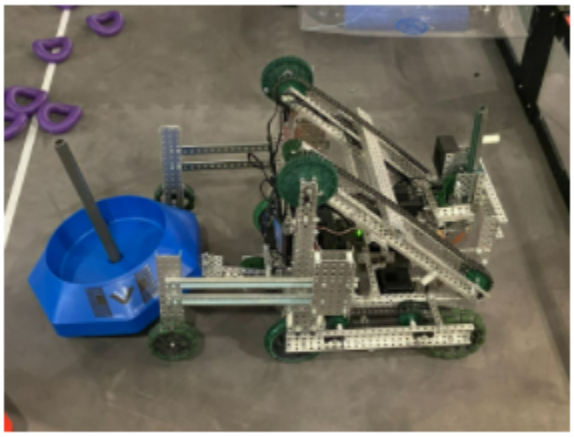
To evaluate their design, Alquist has employees on-site to monitor the printing process. During this evaluation, they document different aspects of its performance such as how much time the 3D print took that day, how much material was used, and how many layers were printed. This allows Alquist to address how they can improve from setbacks they face. Documenting each step of the process also allows them to present the information they gathered to other people on site.



Example of documentation of revisions to make to the robot.

To evaluate our designs, we test our robot every other Friday at the NOVA System Center located in our area. A robot is never perfect on its first run, so it is not a surprise when our robot does not work perfectly during tests. We record videos of its performance so we can rewatch them and evaluate what specific changes must be made. When we don't have access to a full field due to limitations of location and COVID,

we focus on fine-tuning individual parts so we will be able to make the most of testing at the center. Through documentation, we keep track of how our robot has progressed and it allows us to explain our process to others.



Testing our back mobile goal lift at the NOVA center.

Making adjustments to the robot based on testing notes.

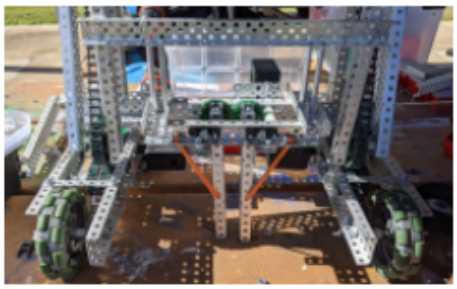
03 | A Future in STEM

At the end of our interview, we asked Aaron and Aiman what they believed were vital skills to have in a STEM career. Apart from technical skills like being able to adapt to new software, interpersonal skills such as teamwork, communication, and organization are essential to nearly every STEM profession. At Alquist, members must relay information to a diverse audience, from STEM professionals to people who do not have a background in the subject matter.

During judge's interviews at VEX competitions, judges do not always have the same level of technical knowledge. It is essential to be able to communicate our team's work in a way that is understandable to a broad audience, regardless of their experience in STEM.

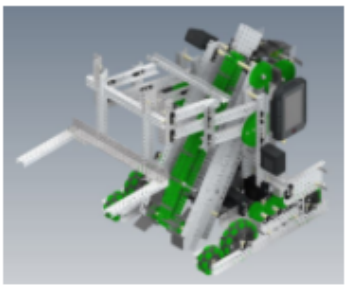
At our first robotics competition of the season with our first completed robot.

As competitors in the VEX robotics program, our team may occasionally experience issues that are beyond our control, such as our robot disconnecting during a match. In our interview with Alquist, we learned that this is a shared experience. As a result of weather restrictions and supply chain delays due to COVID, Alquist's current projects have been met with considerable setbacks. Part of the design process is learning how to embrace those limitations in stride in order to overcome them. The multitude of technical and interpersonal skills that the VEX robotics program equips us with serves as invaluable preparation for future challenges we will face as part of the STEM workforce.



Creating the design to take to our first competition.

Adapting our strategy to the unique match competitors and alliance.



Complete CAD model of our most recent competition robot

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