ASME E-FEST STUDENT DESIGN COMPETITION 2020

SAN DIEGO STATE UNIVERSITY

SKYSCRAPER

ASME STUDENT DESIGN COMPETITION

TEAM

Team goes from left to right: Huy Nguyen, Khalid Almajed, Abdulrahman Alobaidly, Saoud Alasfar

PROBLEM STATEMENT

The American Society of Mechanical Engineers annually hosts student design competitions with multiple design problems. This year's challenge is to design and build an engineering system capable of manufacturing a paper tower. Evaluation will take place in the 2020 ASME E-Fest Student Design Competition in Michigan State University on April 3-5, 2020.

The need is to develop a compact engineering system capable of manufacturing a tower, exclusively out of standard-sized sheets of paper. Design will be evaluated based on manufacturing speed, height of the tower, and the capacity to support aload.

SYSTEM REQUIREMENTS

The system requirements are design constraints and competition rules implemented by the American Society of Mechanical Engineers to ensure competing teams can come up with novel engineering techniques and new design ideas. Team Skyscraper then modified user requirements to engineering specifications to guide team design ideas and implement engineering modifications to the system.

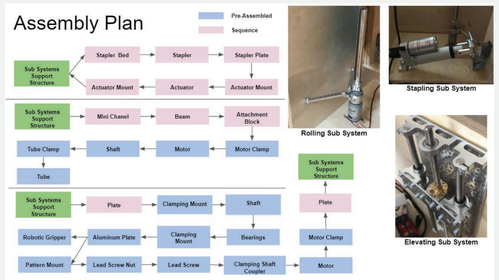
ID	Competition Requirement	Engineering Specification	Tess Results
A	All engineering system components shall fit in a 50 cm^3box.	Device volume shall be less than 95% of a 50 cm^3 box.	**Height: 19 in Width: 18 in Length: 18 in**
B	The device shall only fold, cut, or mechanically join the papers together.	The stapling system shall properly join papers together resulting in a stable tower structure.	**The Stapling system properly stapled 50 papers together.**
C	The Device shall remain in contact with the floor at all times, and may not be secured to the floor.	The base system of the device shall sustain 20 lbs of vertical force and 5 lbs of horizontal force.	**Vertical Force: 25 lbs Horizontal Force: 7 lbs**
D	Rechargeable batteries are the only energy source allowed..	Maximum allowed voltage to run the electronic circuit shall be 80% of the energy source.	✓
E	Only 1 minute is allowed to set up the device for operation.	Device software shall be ready to operate in less than 1 minutes.	✓
F	Papers shall not be modified before and after manual loading to the device.	Mechanical and electrical mechanism shall modify each paper to assigned shape in less than 6 seconds	✓
G	The paper tower shall be stable during the building process and while loads are applied.	Base of the device shall support the load of 5 lbf while operating.	**Vertical Force: 25 lbs**
H	No device component shall exceed a height of 0.5 meter from the ground at all times.	As measured from the ground, the height of any and all components shall not exceed 0.5 meter.	**No components are exceeding the 50 cm height limit.**
I	Only one team member shall manually load the paper, one sheet at a time, so that the device shall connect it to prior sheets of paper.	Device shall join the two papers together in less than 6 seconds.	**Time to Staple Two Papers : 5 seconds**

FABRICATION

In an approach to have a functional testing plan, the team divided the device into 3 subsystems prior to entering the fabrication phase:

1) Stapling System
2) Rolling Subsystem
3) Elevating Subsystem

This furthered the quality and productivity of the assembling and testing phases.



DETAILED TEST PLAN

The table below demonstrates multiple tests conducted as the device is being assembled and tested simultaneously

Test plan #	Function	Part / Subsystem	Equipment used	Test Objective	Test date
A1	Electrical	Actuator, motor shield, Microcontroller	Soldering Kit, Electrical Wire	Adjust linear actuator (PWM) with motor shield	Feb 5
A2	Mechanical	Staple-free Stapler	Weight, Support Plate	Required force to close stapler	Feb 1
A3	Electro-Mechanical	Stapling Sub System, Electronic	(20lbs 8.5 X 11) Printer paper	Using actuator & staple-free stapler to join paper	Feb 6
A4	Electro-Mechanical	Rolling sub system	Clamp, Motor, Power Source	Rolling Motion with extrude cut tube	Feb 8
A5	Electro-Mechanical	Stapling Sub System, Rolling Sub System, Electronic	(20lbs 8.5 X 11) Printer paper	Join paper and Vertically roll individual paper that feed into the system	Feb 10

Test plan #	Function	Part / Subsystem	Equipment used	Test Objective	Test date
A6	Electrical	Rolling Sub System + Electronic	IR Receiver module & Remote control	Using Remote control to operate rolling motion	Feb 11
A7	Mechanical	Elevating Sub System	Lead Screw and Nut	Using Lead Screw and Nut to convert rotary movement to linear movement	Feb 13
A8	Electrical	Servo	Tape, Arduino software, Arduino board	Servo min & max range	Feb 20
A9	Electrical	Robotic Gripper	foam	Robotic Gripper gripping strength	Feb 27
A10	Mechanical	Elevating Sub System, Robotic Gripper	Rolled paper tube	Gripping and Elevating motion	Mar 6

DEVICE TESTING

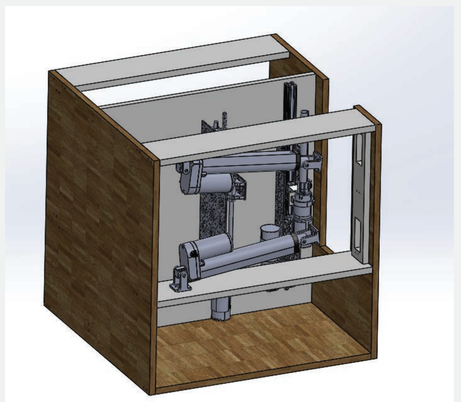
The table below shows the results of the device's progression; demonstrating the issues and adjustments made to build the final product.

Run #	Issue	Cause	Adjustment	Max Height from the Ground	Max Carrying Weight	Building Time
1	Actuator Stalled	Soldering errors, motor controller A failed	Made adjustment to soldering process	NA	NA	NA
5	Failed to join the load sheet to the tower	Motor operated at a higher rpm	Adjust motor PWM	NA	NA	NA
8	Robotic Gripper is wide	NA	Adjust servo max position to 100 degree, adjust IR Remote code	NA	NA	NA
14	NA	NA	Pressure plate dimension	14 in	NA	10 mins
17	Robotic Gripper return to void set up position when enduring higher gripping force	?	Testing Current delivering to the servo using Voltmeter/Servo position adjustment	20 in.	NA	10 mins
21	Subsystem Failed to response to IR Remote	NA	Checking Code, reduce IR remote delay time, adjust power deliver to the microcontroller	NA	NA	NA
26	NA	NA	Increase Rolling Friction by adjusting pressure plate	25.5 in	NA	10 mins

Control Elevating Sub System with IR Remote.

Top View

Stapling & Rolling



CAD Design

PERFORMANCE RESULTS

Skyscraper reached a height of 28" in 10 minutes.
Skyscraper reached a height of 22" while supporting a 5 lb load.

SPRING 2020