



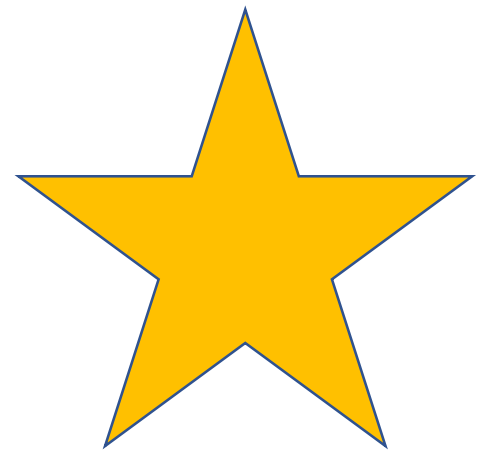
Prize Winner

Computer Programming, Apps & Robotics Year R-2

Nivaan Sardana

St Peter's College

Oliphant Science Competition



Mindstorms EV3 Robotics

Science Project: House Helper Robot

Showing how Circular motion gets converted to linear motion

Nivaan Sardana
St. Peter's College

Attempted during: School Holidays, JULY 2020

House Helper Robot



How the Idea Came?

- First of all I had to choose something to make. For that I had to read rubric. The rubric said that the project needs to show some science and can also be useful having some purpose.
- I did not know what to do that will show some science. So, I asked my Dad. He asked me to look at 6 simple machines.
- I did Google search for simple machines in physics that was told to me by my father. I found six simple machines: 1.Wheel and axle 2. Inclined plane 3. Wedge 4. Lever 5. Pulley 6. Screw.
- These simple machines were easy to understand, but I still did not know what to choose and make from Mindstorms.
- So, I asked my Dad again. He said that simple machines can make complex machines. They are made when simple machines are combined to make a complex machine.

How the Idea Came?

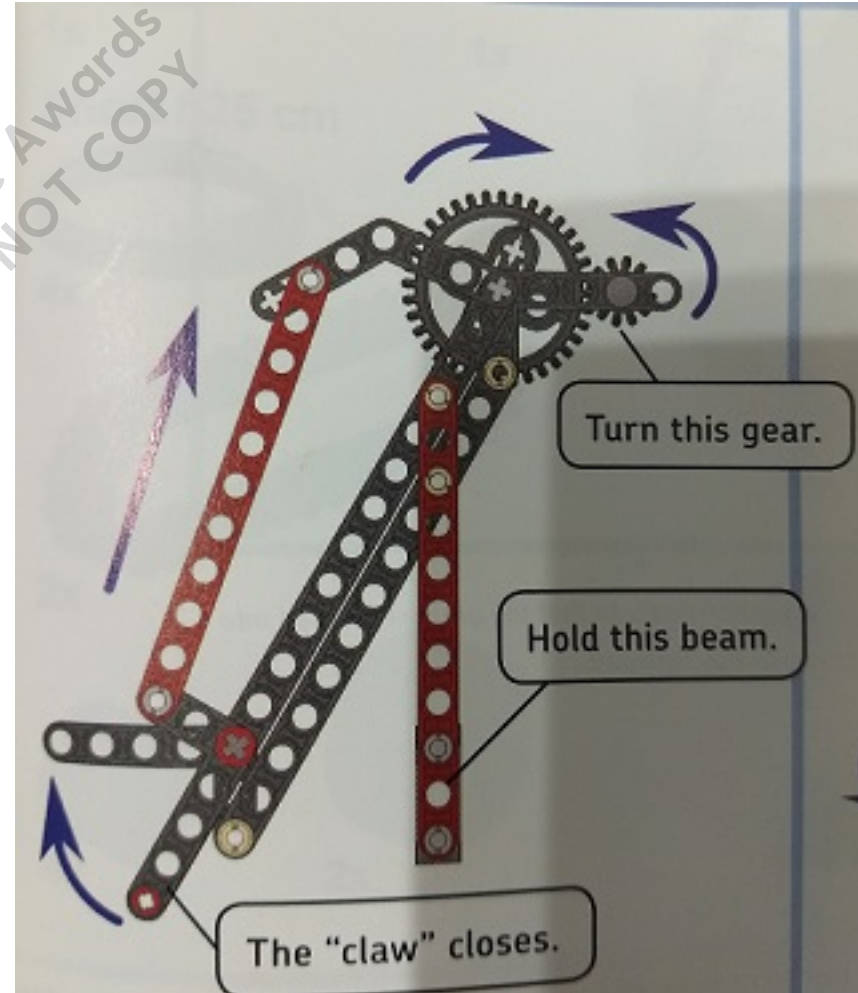
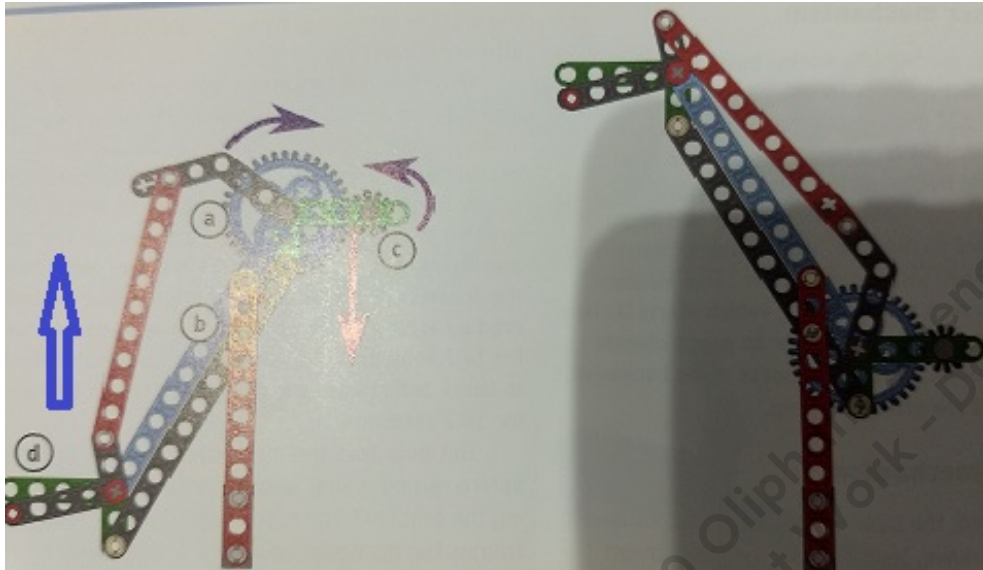
- My Dad asked me to think about all models I made with Lego Boost and Lego Mindstorms. - I had made all their models earlier using their instruction book.
- So, I discussed some models, like Rapter, Tracker, Everstorm, Spiker and Gripper, with Dad. All were complex machines.
- I still did not know what to make that will be my own creation and will show science.
- Then my Mom said why not make something that will help deliver objects from one place to another. She always has to deliver things (like food, milk, spoon, water, towel) to me when I am busy playing, watching TV or reading books. So, the idea of delivery machine/House Helper.
- I just did not want to make a simple delivery machine that will be similar to other models in EV3 instruction booklet. I wanted to make something different and not boring.
- So, I said that it can also have a mechanism to have a tray in it that will go up and down.
- Everyone liked the idea, so the idea was finalized.

How I Researched to Build My Machine?

- I did not know how to build the machine robot. So, first I drew a sketch of what I was going to make.
- I then picked up my Book – THE LEGO MINDSTORMS EV3 DISCOVERY BOOK by LAURENS VALK.
- I went through several pages to look for ideas to make my machine. I liked the pictures given in pages 265, 280, 281 and 296. They all looked similar with a lot of wheels attached to make a system that goes up and down.
- Now, the challenge for me was to make my own machine and not just copy them.
- For a few hours over 2-3 days I tried to think of a mechanism to make. But, it was difficult for me.

How I Researched to Build My Machine?

- Book – THE LEGO MINDSTORMS EV3 DISCOVERY BOOK by LAURENS VALK.



How I Researched to Build My Machine?

- Then one evening my Dad explained that the core mechanism basically looks like a forklift. So, I did a lot of internet research to learn how to make forklift using Mindstorms.
- I also saw some videos on YouTube.
- Then my Dad told me to do research on how to convert circular motion into linear motion.
- Then I did internet search on it and after one hour of research again I found this YouTube channel called *Builderdude35* <https://youtu.be/q5b-uP05ELA> .
- That was an excellent small video. Now, I thought I had found a simple way to build my own machine.

Building My Machine

- *Builderdude35* <https://youtu.be/q5b-uP05ELA> told 4 ways to convert circular motion to linear motion. He suggested that his most preferred option was to make a 'Rack Gear'.
- I decided to follow his advise to make Rack Gear, but I did not have the pieces to make it because he was using EV3 Core and Expansion set. I had EV3 Home Set only, which I bought last year on my Birthday.
- And my Dad said that I can use my own imagination to make my own 'Rack Gear' and I can borrow some pieces from my many other Lego sets.
- I could take inspiration from the idea of *Builderdude35*, but I have to create my own system that will make the tray go up and down.
- So, next 2-3 days I spent making my machine.

Building My Machine

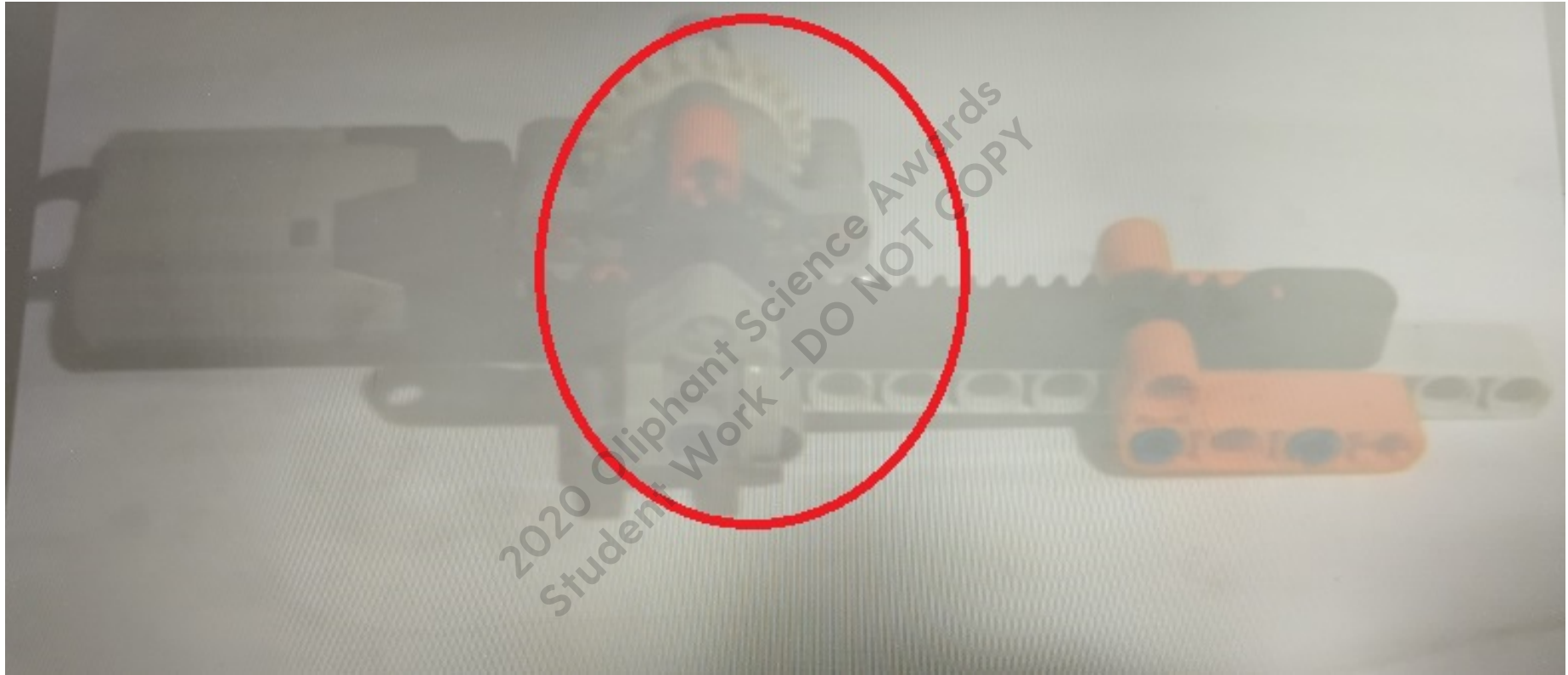
- The first day I worked on the bottom platform that will move and making a good design to attach the EV3 Brick.
- The last model that I developed from Mindstorms was called Robodozer. The instruction for that was downloaded by my Dad. These are extra machines made by other people but not Lego Professionals.
- After making Robodozer, I found that it was not so good because changing batteries was kind of impossible without dismantling all of Robodozer.
- I did not want my machine to be like that. So, I spent a lot of time thinking where and how to put EV3 Brick on my machine so that it will be easy to replace batteries.
- I also spent a lot of time building a beautiful tray in which something can be put in.

Types of Gear Systems

TYPES OF GEARS

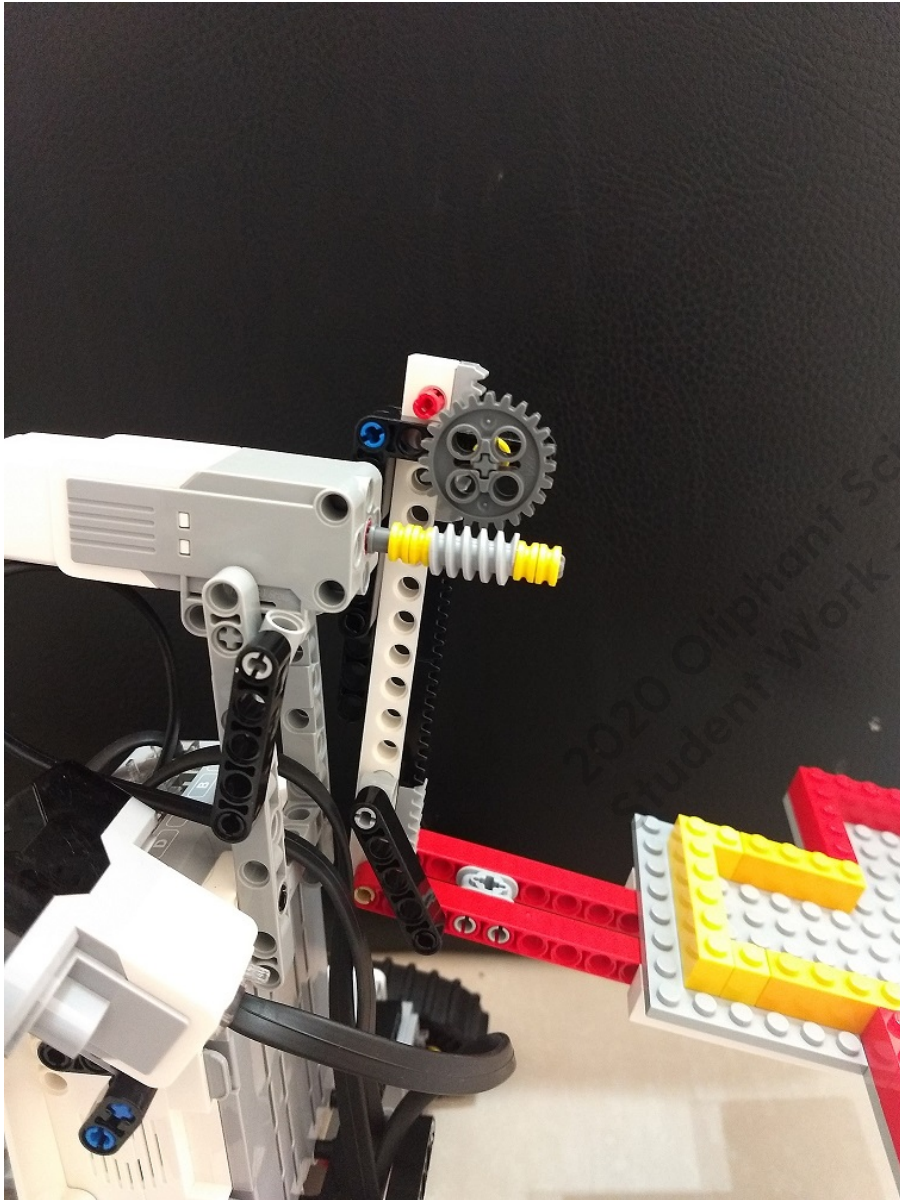
1. SPUR GEAR 	2. HELICAL GEAR 	3. HERRINGBONE GEAR 	
4. RACK AND PINION 	5. BEVEL GEAR 	6. SPIRAL BEVEL GEAR 	
7. SCREW GEAR 	8. WORM & WORM WHEEL 	9. MITER GEAR 	10. INTERNAL GEAR 

Builderdude35 Gear System



Please see - key pieces to make this are not in Mindstorms Home edition that I used to make.

My Rack and Pinion Gear

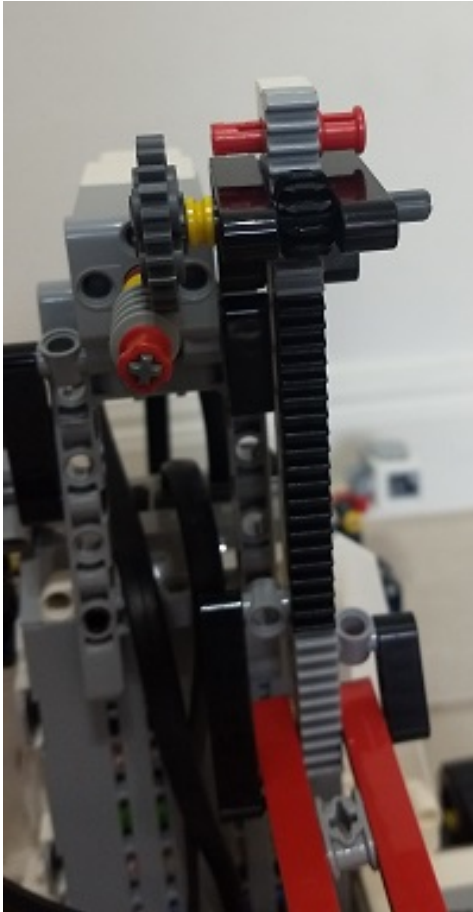


To make my rack gear I had to borrow tooth bar from my other Lego Sets (Royal Talon Fighter Attack 76100 and Boost). But I still had a couple of important pieces missing from Expansion set to make it.

It took me nearly the whole morning till afternoon to figure out how to make the rack gear mechanism using what I have.

I did not have the ev3 Expansion set that's why I had to make the tooth bar and the rack gear - it was a bit hard for me to make rack gear without the ev3 Expansion set.

Rack Gear Mechanism



Core motors are Spinning motor and ev3 Brick. But the main motor is Spinning motor. So this is what these motors do. First Spinning motor powers the rack gear. Then the rack gear powers another wheel that powers another black wheel that makes a tooth bar go up/down. So, if we attach a tray to the tooth bar, it will also go up/down.

The two wheel system in rack gear (i.e. worm gear) makes the up and down movement go slow. If it is only one wheel rack gear then it goes very fast and can drop things off the tray. Rack gear mechanism also prevents backlash.

Building My Machine

- After I made Rack Gear, I attached a bracket to the EV3 Brick so that motor of rack gear can be put.
- Then I tested my Rack gear again and it was working well.
- I also attached IR sensor to EV3 Brick so that I can operate my robot using IR remote as it is the signal receiver.
- IR sensor also looks like two eyes, which I really like.
- Then I attached my tray on the extension of the tooth bar in rack gear system. The tray was heavy so the axle that powers rack gear will always pops out from the motor when it is running.
- Then I made another (second) tray using Classic blocks. This was 90 grams and it was still heavy.
- So, I made third tray using Classic blocks. The whole process of making tray was exhausting.
- Finally, the third tray was not that heavy.

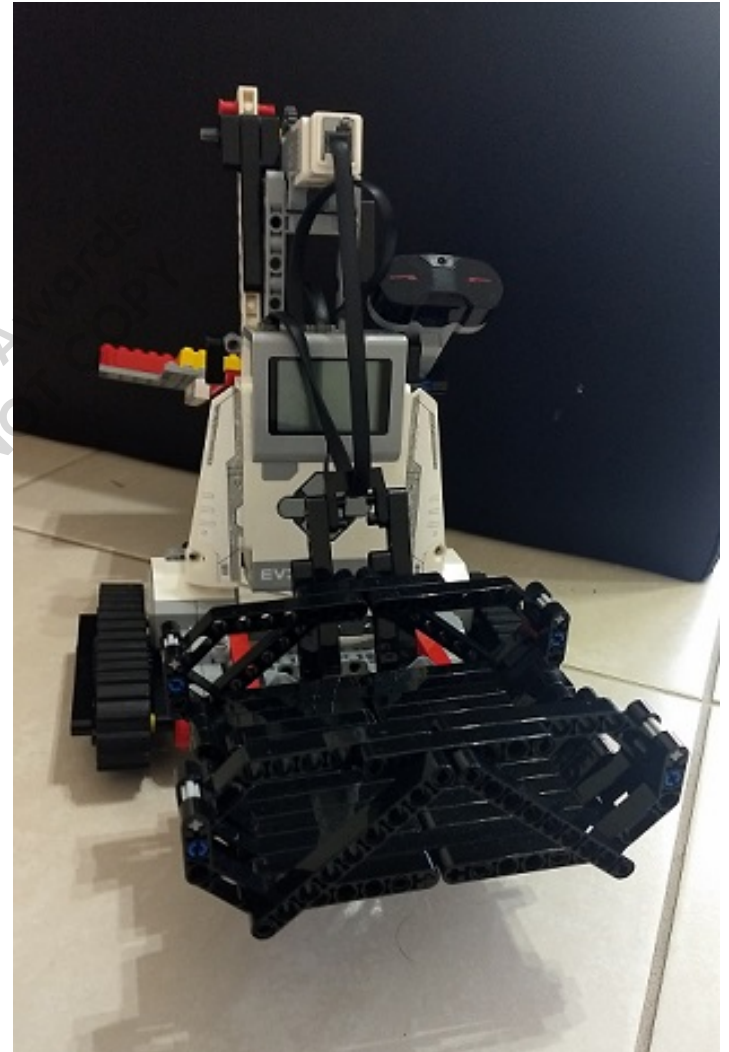
Building My Machine

- To balance the robot, I put my first tray in front of the machine. It was more than 140 grams so it was able to balance the back part with rack gear.
- The motor powering the Rack gear also had to be adjusted because it was tilting. To make it straight I pulled the wire attached to it so that the pull makes the motor more horizontal. I also made a small trap that will keep the wire pulled.
- So, my robotic Helper Machine now had two trays – one operated by rack gear and another in front.
- Now, my machine was ready. It is not perfect and a bit wobbly, but it works well with remote control.
- The machine is still helpful as it can carry small things (like pen, rubber, paint brush), but not big things (like glass of milk or water). So, it is a model.

Building My Machine



Tray on Rack Gear System



First Tray I made – Front Side

Coding

- I did coding for Lego Boost, but I do not know coding for Mindstorms. I have to learn it for Mindstorms.
- The rubric said that coding is not important. It is the idea that shows some science that is important. So, this is what I tried to do.

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Thank You!

- It took me full 2 days to make this presentation.
- I had learnt making presentation in Year 1 in my old school, The Southport School, Gold Coast.
- And, in St. Peter's I made and presented my power point slides in Term 2 of this year.
- After I made slides, my Dad helped me in correcting my mistakes and making pictures of right size. He also helped me with making my bullet points clear. It took us about 2 hours more.

