The Robotic Direct Driller
Team 5606A

Traditional planting methods involve five steps:

1. Ploughing
2. Cultivating/Power Harrowing,
3. Levelling
4. Rolling
5. Seeding

This method is destructive to the top soil, wasteful of fuel, resources and time. I wanted to design a robot as an alternative to this process using minimum tillage methods.

Minimum Tillage or Direct Drilling has many advantages. They are discussed at length on pg 3 in the following article http://www.cabi.org/gara/FullTextPDF/2009/20093343681.pdf

In summary they are

- An 80% reduction in fuel usage, work hours and soil compaction
- Elimination of the destruction of soil structure which allows the build-up of soil microbial activities.
- Topsoil erosion is radically reduced and soil moisture loss is reduced, especially in dry areas.
- Reduced Soil Compaction

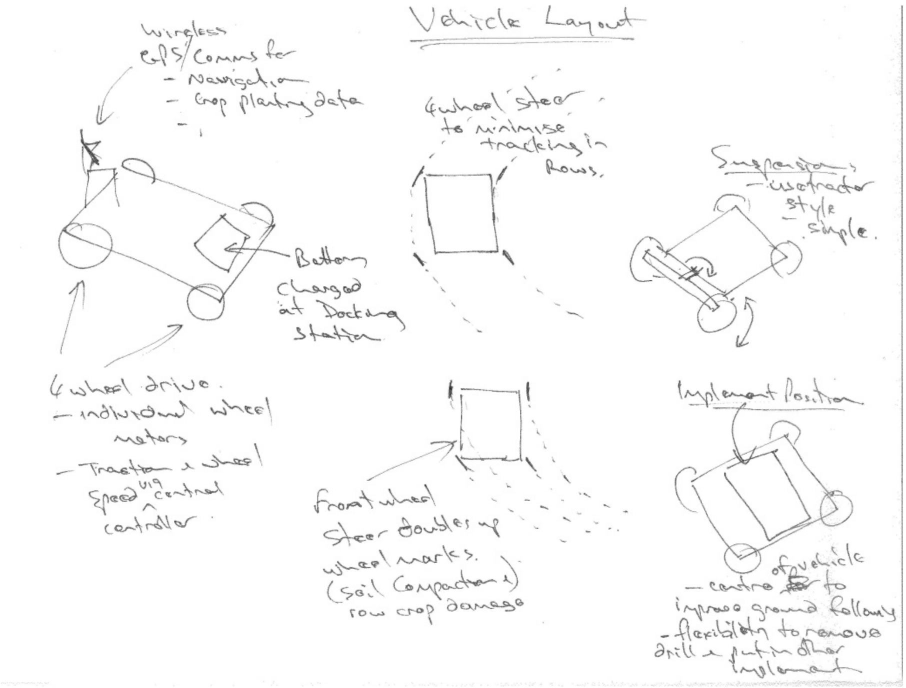
Having looked at the Autodesk Sustainability workshop, I decided to design a direct drilling robot that will use lightweight materials such as aluminium, use a minimum of components which are designed to reduce maintenance time. This means that the robots' mechanisms should be simple, light and efficient.

THE DESIGN PROCESS:

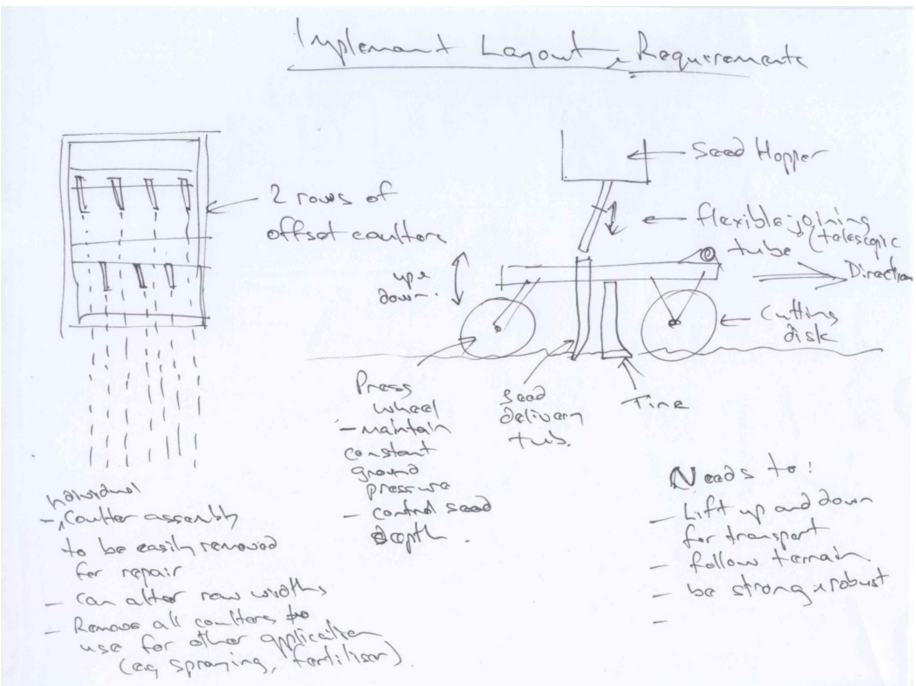
CONCEPTUALISATION:

We firstly considered the vehicle layout and what characteristics it should have.

The chassis design needed to be flexible, simple, use as few materials as possible, have a large centre space to include the drill, have a tight turning circle, and suspension to stay as level as possible on normal farming ground.



We then considered the specific requirements of the drilling implement.



I then created a series of subassemblies of the different key components of the robot

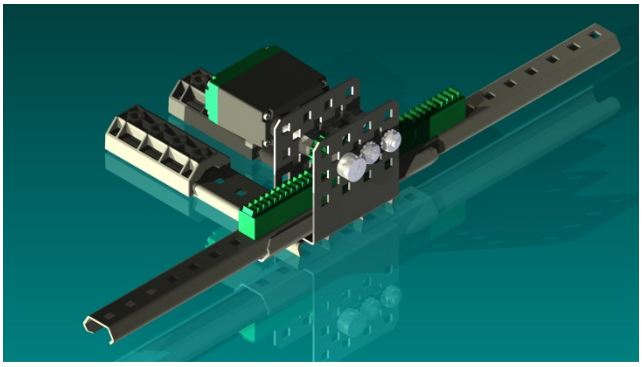
DEVELOPMENT OF CONCEPTS

1. **WHEEL ASSEMBLY**

There is a motor on each wheel eliminating the need for drive shafts or differentials, also giving four wheel drive for farming terrain. This decreases the number of moving parts, extending the service life of the robot and reducing maintenance. This also allows rapid replacement and "on-the-fly" upgrades.

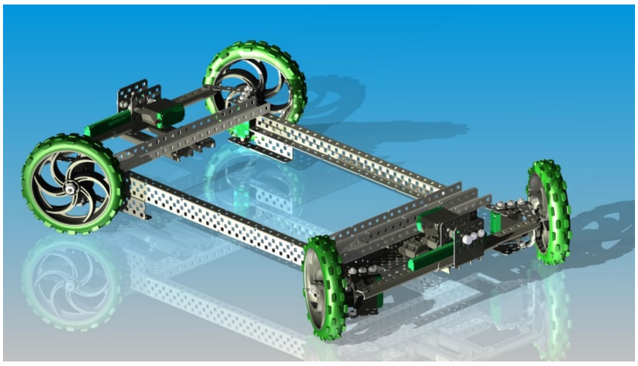
2. **RACK AND PINION STEERING.**

I decided to use this both front and back to give the tightest turning circle possible. It also eliminates the need for skid steering which will damage the surface of the soil and confines the path of a turning vehicle to a single track. (important for row crops)



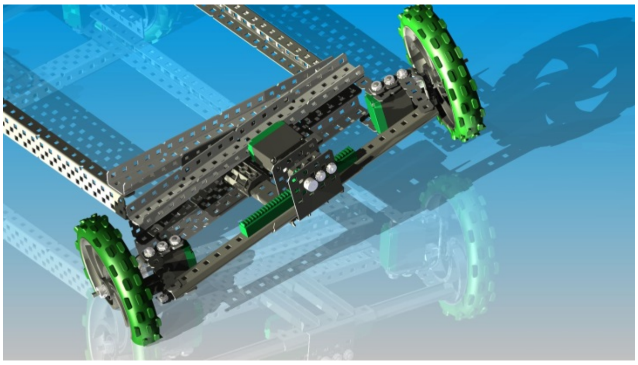
3. **THE CHASSIS**

I then created a frame around the basic components outlined above. There is a need for a large central space to incorporate the coulters or future development of other farming utilities.

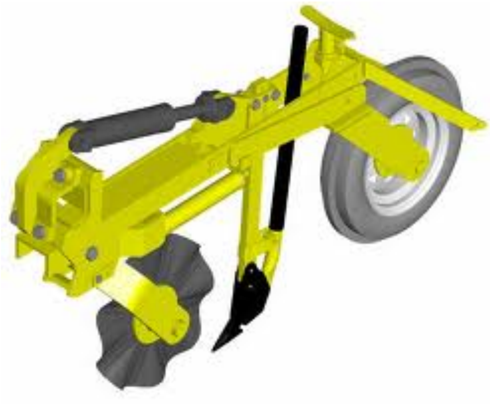


4. **SUSPENSION**

This suspension type is very simple, robust and reliable as it requires only one moving part.

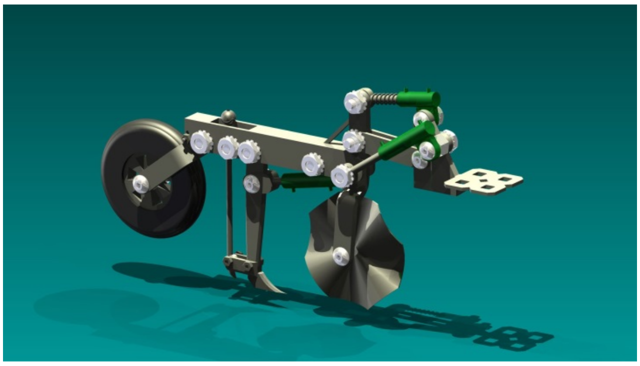


5. COULTER



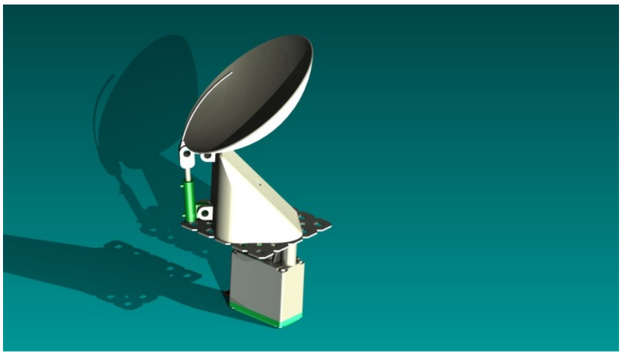
This is the key component of the direct drilling process.

I found this image of a direct drill coulter on the internet. I decided to base my Autodesk design around this image.



The Coulter takes the seeds from a hopper and plants them in the ground. The Leading Disc cuts a thin slot in the ground. The Tine in the centre delivers the seed at the correct depth. The entire frame has a hydraulically adjustable ground pressure spring on the top to force the rear tyre to follow the contour of the ground. The final hydraulic ram at the front allows the entire unit to be raised for road travel.

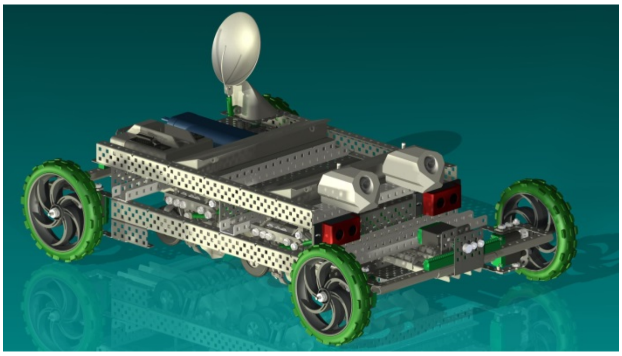
6. COMMUNICATION TOWER



This transfers information about ground coverage, seed levels, task completion, weather and current user instructions. This means that the robot can avoid planting in adverse weather, inaccessible or useless terrain and obstacles. The User can remotely change the pathway and the depth of planting. A GPS uplink allows accurate plotting of the robot's location.

The robot would be powered via a docking station which would use solar energy for recharging the batteries and also to protect the robot from adverse climatic conditions. The station would also contain automatic dispensing facilities of potential seeds for use as required.

7. **FULL CHASSIS**



There are 17 coulters in two offset rows incorporated into the original chassis. The hoppers on the top contain the seeds and sliding ball joint connecting rods transfer the seeds from the hoppers to the coulter.

AUTODESK FEATURES USED IN DESIGN PROCESS

DRIVING CONSTRAINTS

This feature allowed me to see the degrees of freedom that any particular component had and at what angle of rotation it would collide with another part. It also allowed me to see my designs in motion.

INVENTOR STUDIO

This was used to make the animations in the YouTube video and to render the images in this presentation.

BALL AND SOCKET JOINT

This allowed me to constrain my ball and socket connecting rods quickly and easily.

Autodesk Inventor design by Mitchell Coleman