MECHANICAL ENGINEERING DEPARTMENT

# AUTOMATIC CLOSING WINDOW

## ASSESSMENT III- GRADUATION PROJECT


Advisor:
Dr. Emad Y. Tanbour

- Mohd. Abdul Mohsin Khan
- Mohd. Al- Ghamdi
- Nemer Saab

# Contents

- Introduction
  - Problem definition
  - Scope of project
  - Statement of Purpose
- Concept design
  - Residential window
  - Motion options
  - Rain Sensors
- SolidWorks® designs
- Videos
- Design Analysis
- Patent Search
- Conclusions and Limitations

# Introduction: Problem Definition

- To design a residential window that closes automatically under the influence of rain.

# Introduction: Scope of project

- The window will be designed to be sensitive to rain only. Its components will be so designed so that it can be easily manufactured and would be affordable to the common man.

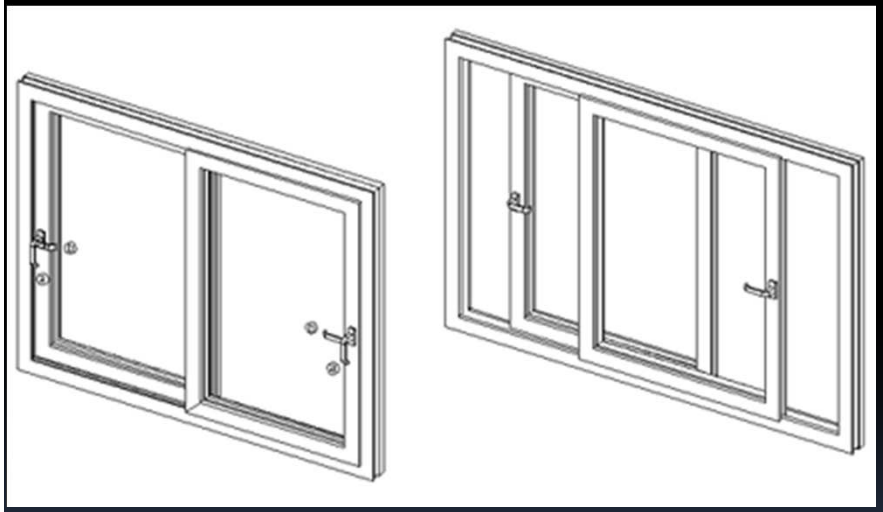
# Introduction: Statement of purpose

- The purpose of this project is to design a window that will close automatically when it rains or snows.
- The aim for the manufacture of this product is to avoid all the hassle caused in continuously raining areas by closing the windows automatically.
- Another purpose is to practice the application of computer aided design program (SolidWorks®) for the purpose of designing machines.

# Concept Design: Residential Window

- A typical house window in the kingdom is made of an aluminum frame. The glass used is double paned. Each frame has two windows, both of which are sliding.
- But for the purpose of ease, our design has fixed one window and made the other movable.

# The Residential Window



# Advantages for the sliding windows

- Smooth, quiet sliding motion for ease of opening and closing
- Strength and durability
- Security
- Weatherproof
- Improved airflow that you can regulate according to your needs
- Integrated insect screens
- Easy to clean and maintain
- Wide range of colors to suit your interior and exterior materials and designs
- Window glazing for improved energy efficiency and insulation.

# Why did we choose aluminum?

- Aluminum window frames are
- Light
- Strong
- Durable
- easily extruded into the complex shapes required for window parts.
- Aluminum frames are available in anodized and factory-baked enamel finishes that are extremely durable and low-maintenance.

# Concept Design: Motion options

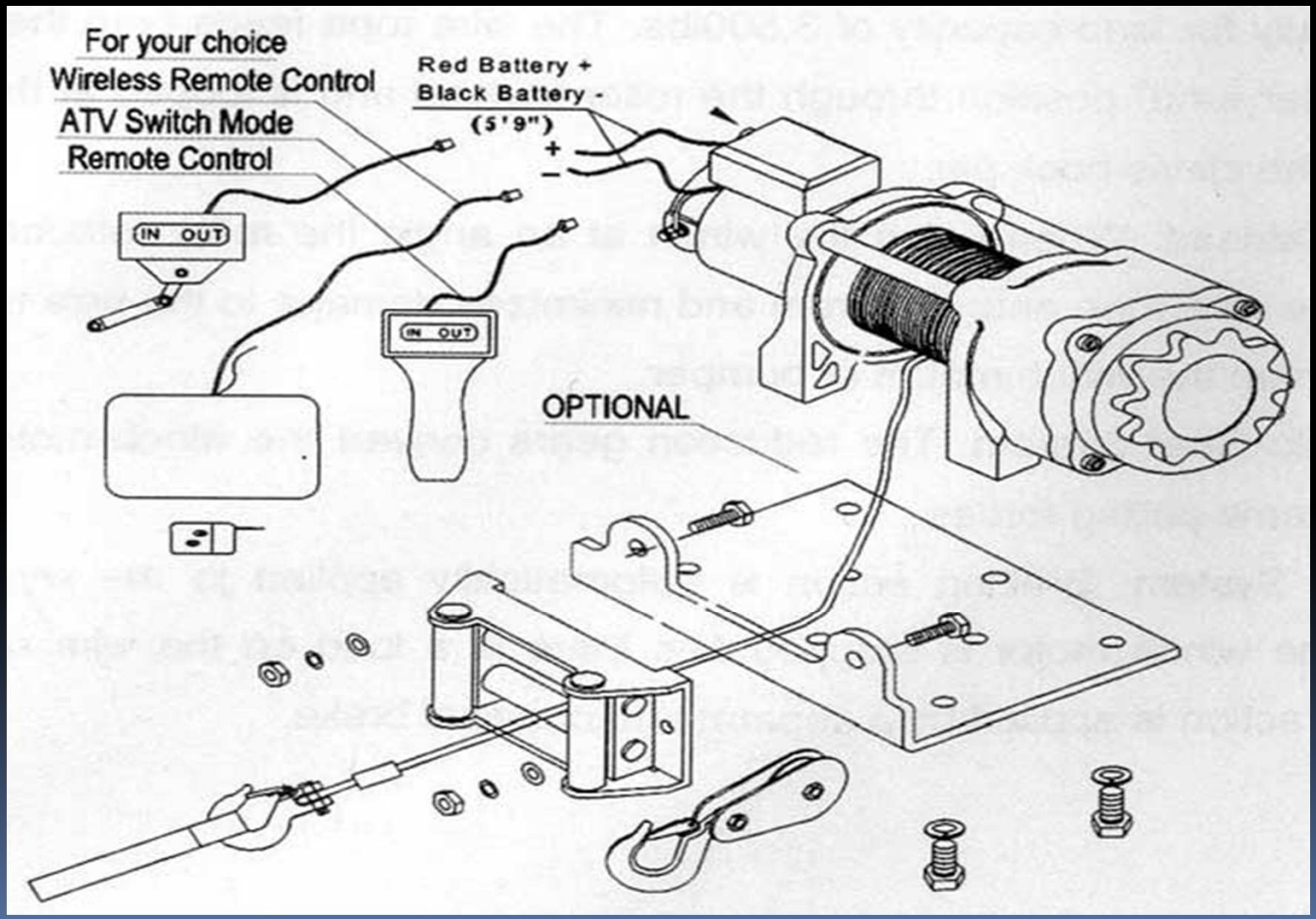
- Rack and Pinion: The first idea of a mechanism to open and close a window was a simple rack and pinion gear assembly. The window will sit on the rack of the assembly where the pinion gear, connected to an electrical motor, moves the rack with the pane causing it to open or close.
- This idea was rejected for many reasons. This assembly is noisy and causes discomfort to the residents of the room. Another reason we rejected this mechanism is that it uses a lot of power to operate. And a third reason is that it would be unappealing from an architectural point of view.

# Rack and Pinion

# Concept Design: Motion options

- Rope and Pulley mechanism: Our second option was to use the simple rope and pulley design operated with a motor.
- This was also rejected because the amount of force needed to operate this kind of assembly was very high and the fact that this assembly would be very expensive.

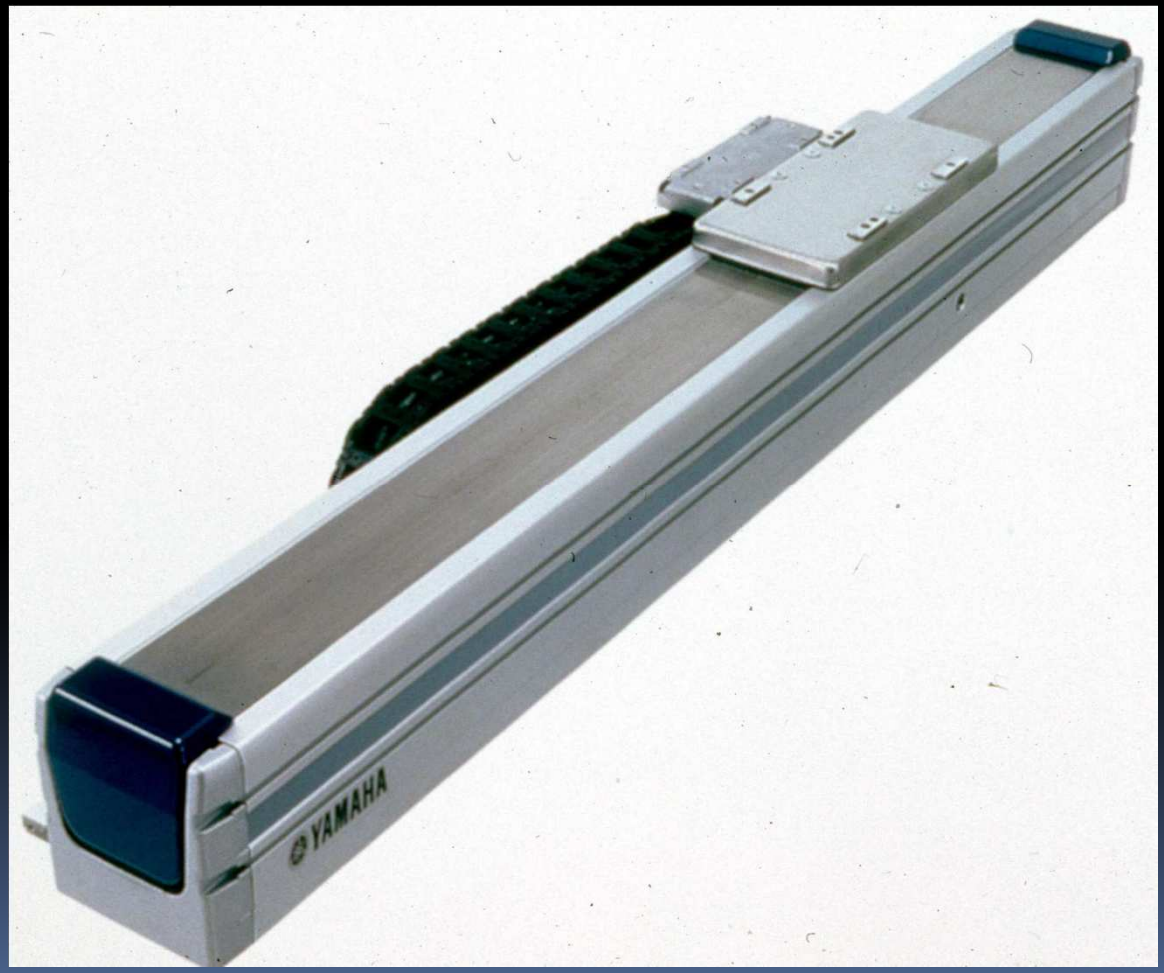
# Rope and Pulley mechanism



# Concept Design: Motion options

- Linear Motors: A linear motor is an electric motor that has had its stator and rotor "unrolled" so that instead of producing a torque (rotation) it produces a linear force along its length .
- This motor consists of two main parts, a stator and a motor.
- The stator is a stationary that would generate a magnetic field causing the motor to slide – friction free – on the stator in a linear motion.
- When switched on, the motor will slide causing the window mounted to it to move with it.

# Linear Motor



# Concept Design: Motion options

- Linear Actuator: The linear motor had all the features that we needed in terms of force and easy operation but the main problem was with the price.
- The second best thing was the nut and screw linear actuator.
- The linear actuator is an electrical device that makes use of an acme screw and gears and helps in linear motion in a smooth fashion.
- It is very compact in size, very easy to install and operate. I
- t also can be hidden so it will have no effect on the decoration of the room. And most of all, its price was in the range that we put to the design.

# Linear Actuator

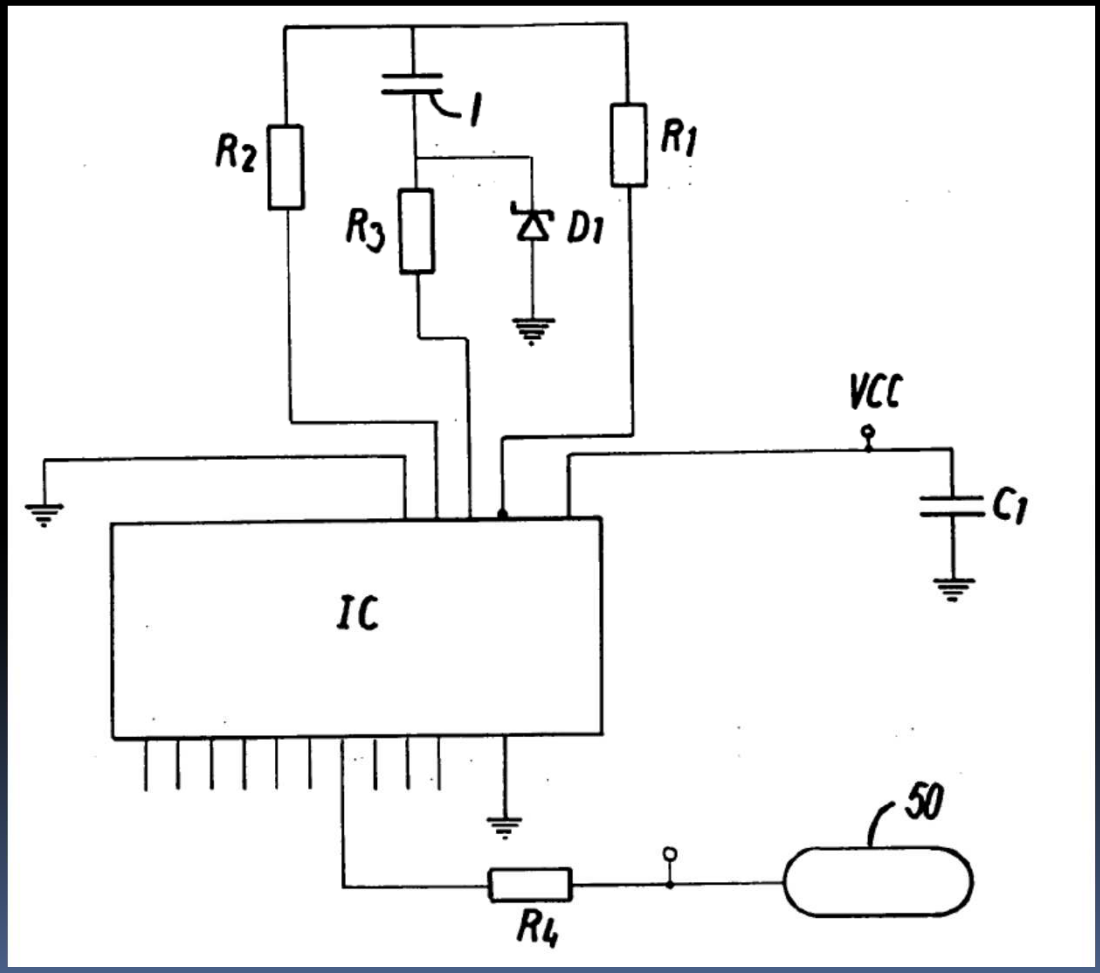
# Features of the Linear Actuator

- Metal spur gears offer strength and durability
- The aluminum zinc alloy housing resists corrosion and provides protection from dirt, dust and humidity.
- Up to 1.75 in./sec. Travel Speed
- The M-Track 1 has a temperature operating range of –15° to +150° F
- Standard stroke lengths of 2, 4, 6, 8, 10, 12 inches are available
- Internal limit switches automatically shut off the unit at end of stroke
- Optional potentiometer can provide positional location feedback

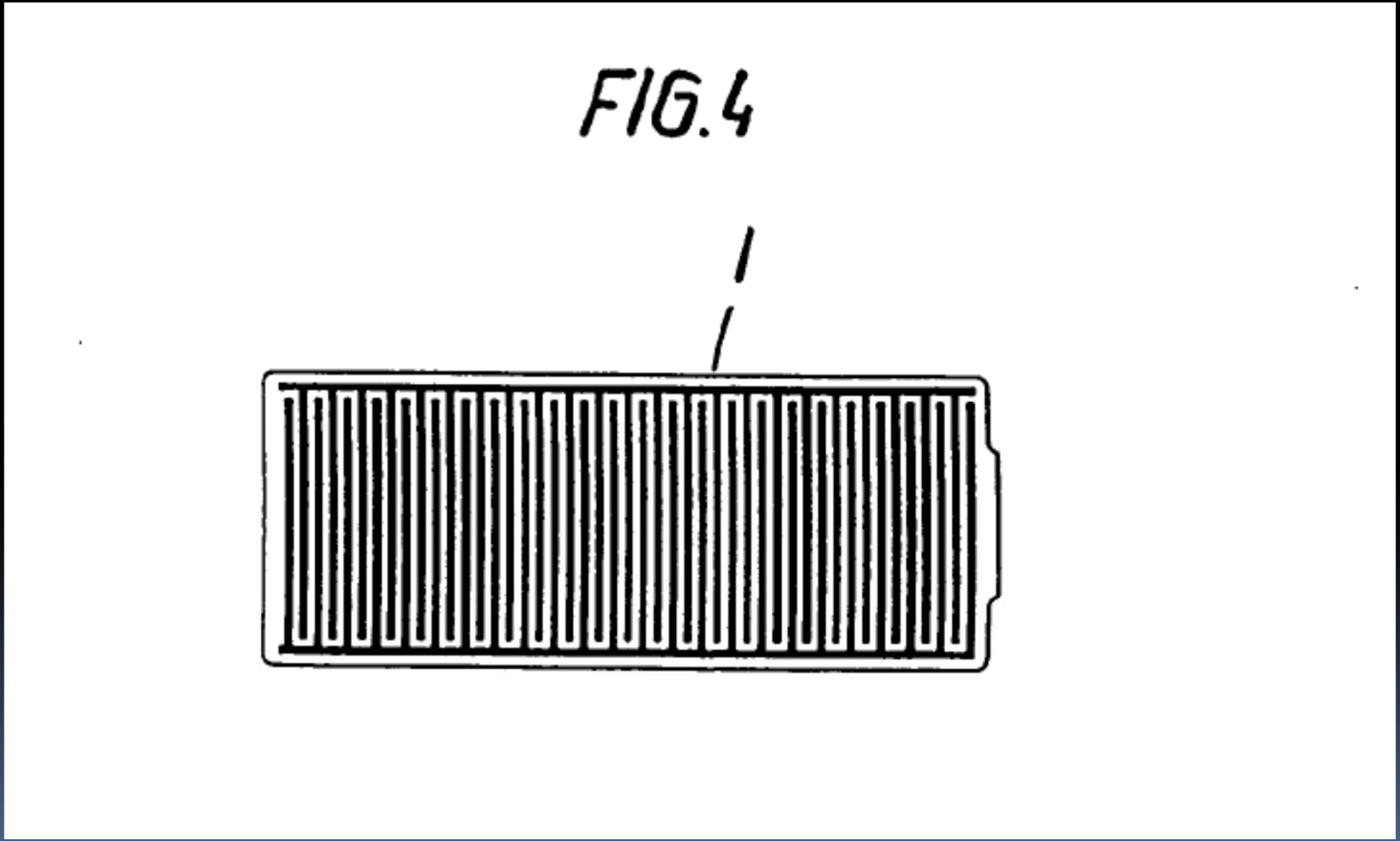
# Concept Design: Rain Sensors

- A rain sensor is a device which is actuated by rainfall. For the purpose of our project we considered the use of the capacitive sensors.
- Capacitive sensors are preferred over resistive sensors as they are less prone to false detection of rainfall.
- E.g.: if the resistive sensor gets contaminated by a carbon containing particle, the resistance changes and the system is triggered, whereas this is not the case with the capacitive sensors.

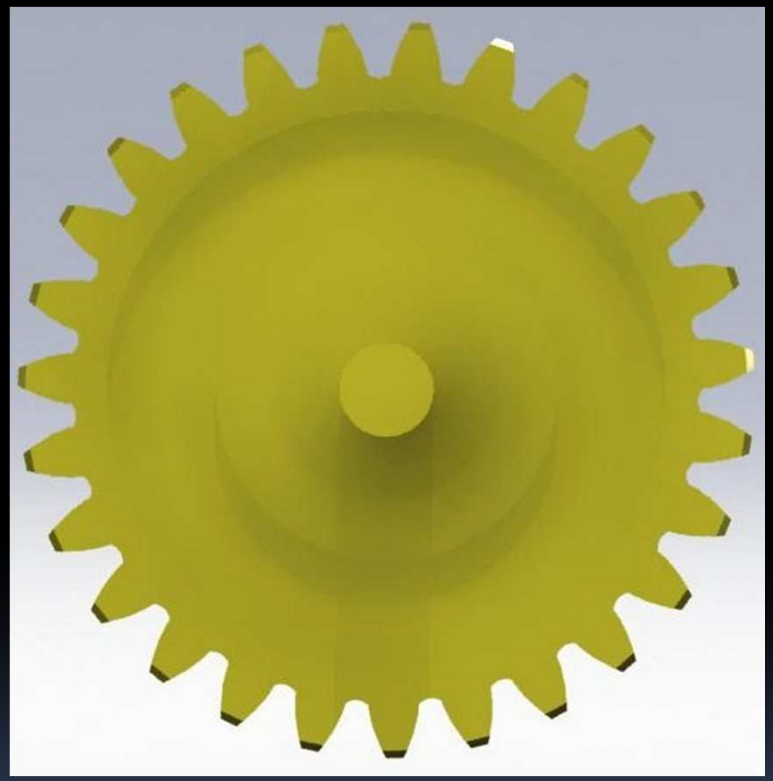
# Concept Design: Rain Sensors

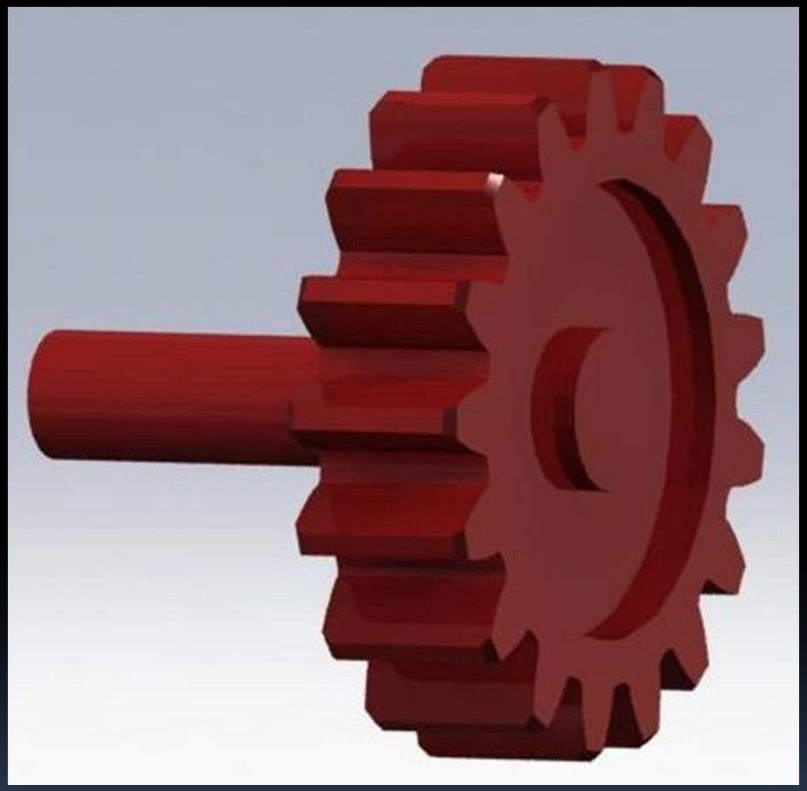


# Concept Design: Rain Sensors

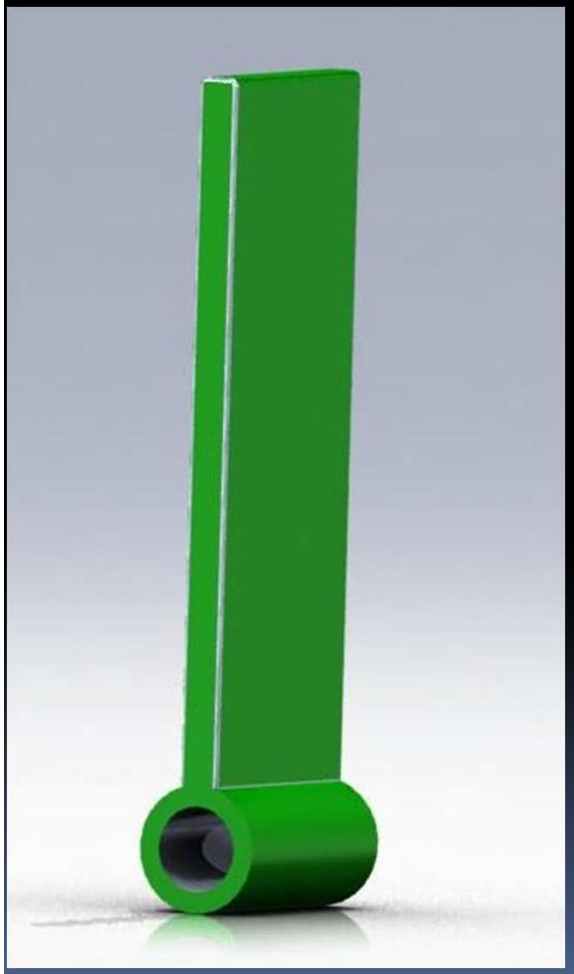


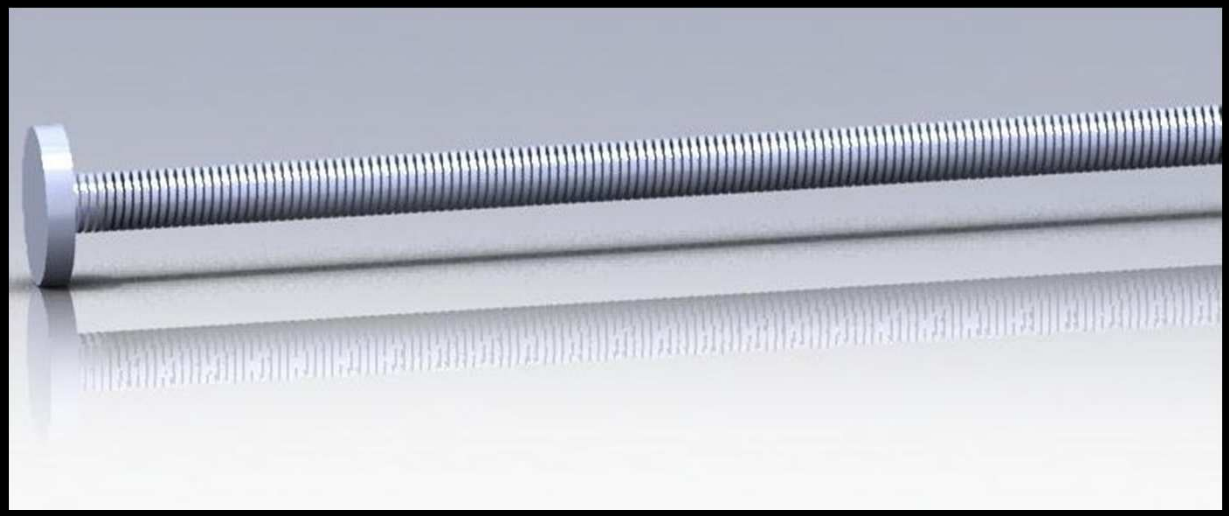
# SolidWorks® design of the gears

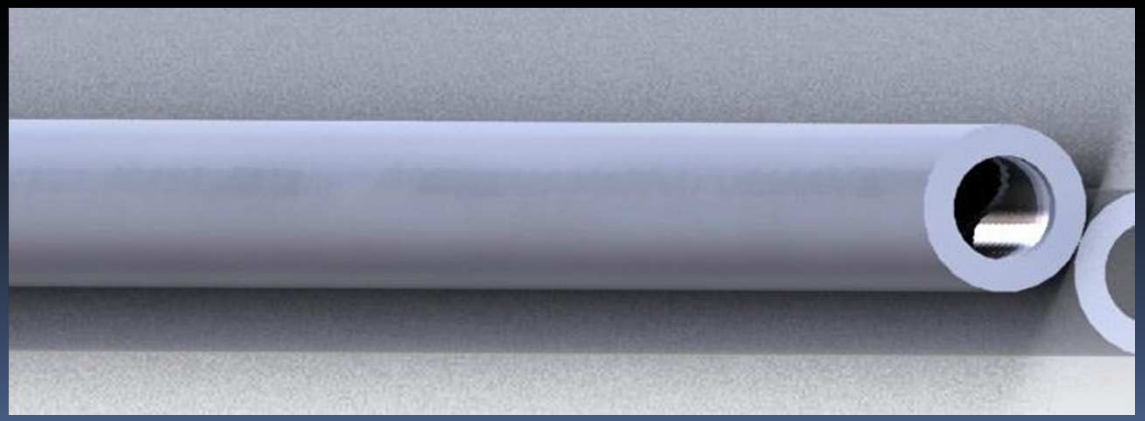




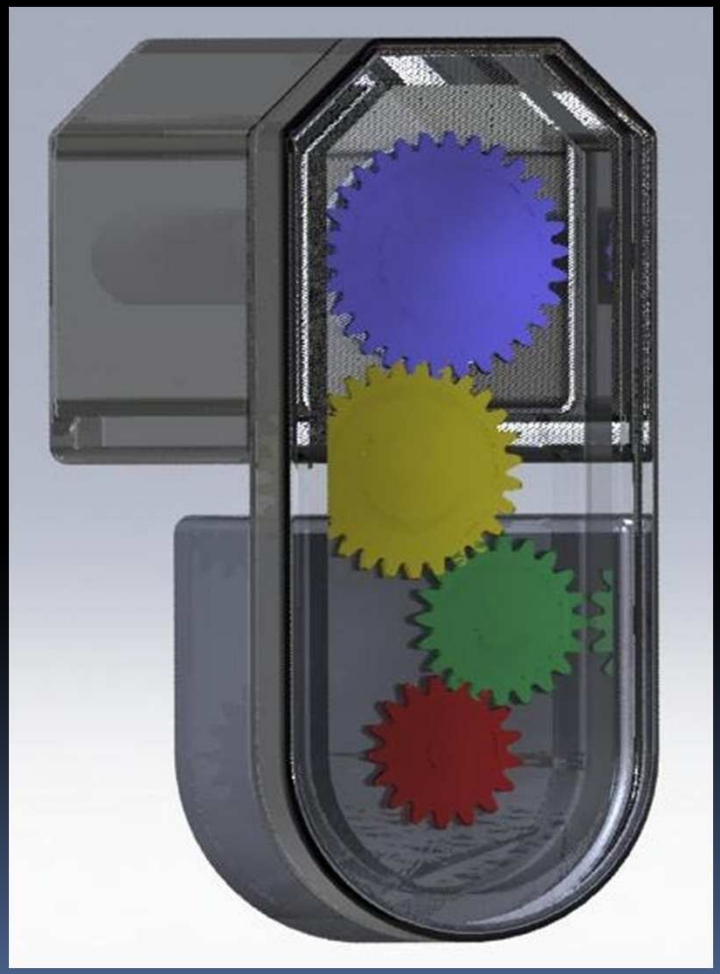
# SolidWorks® design of accessories

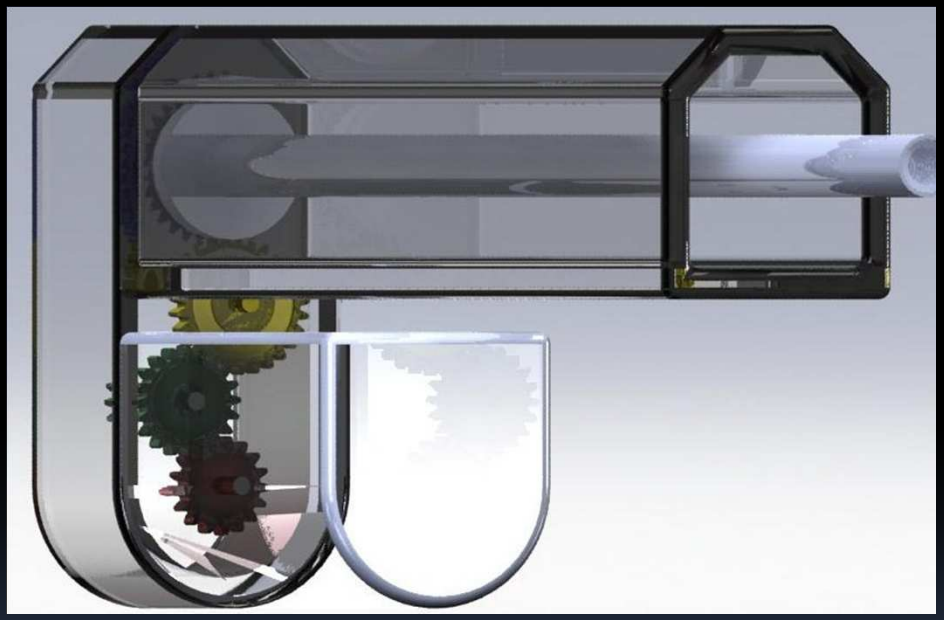




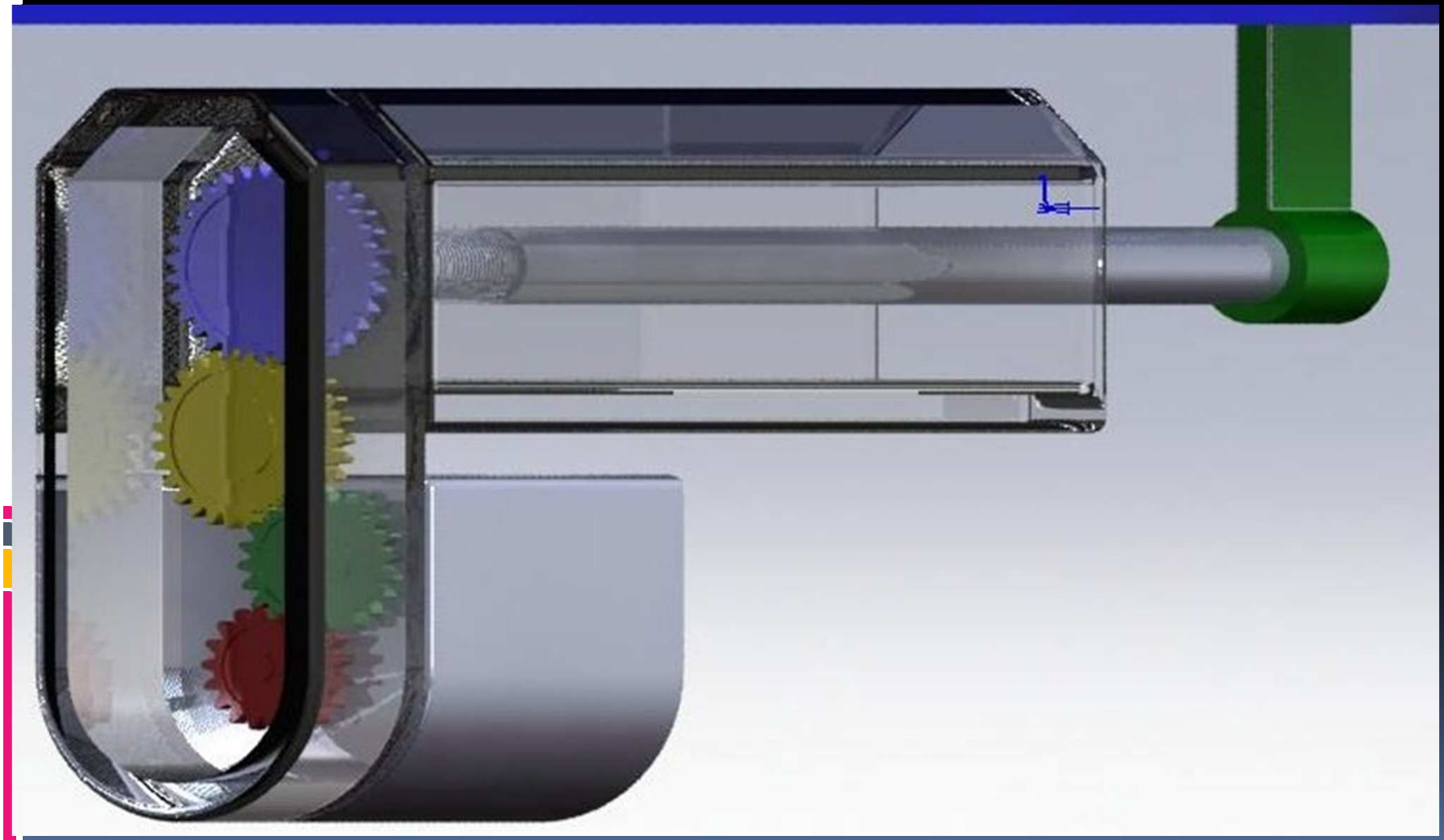


# SolidWorks® design of the Linear Actuator

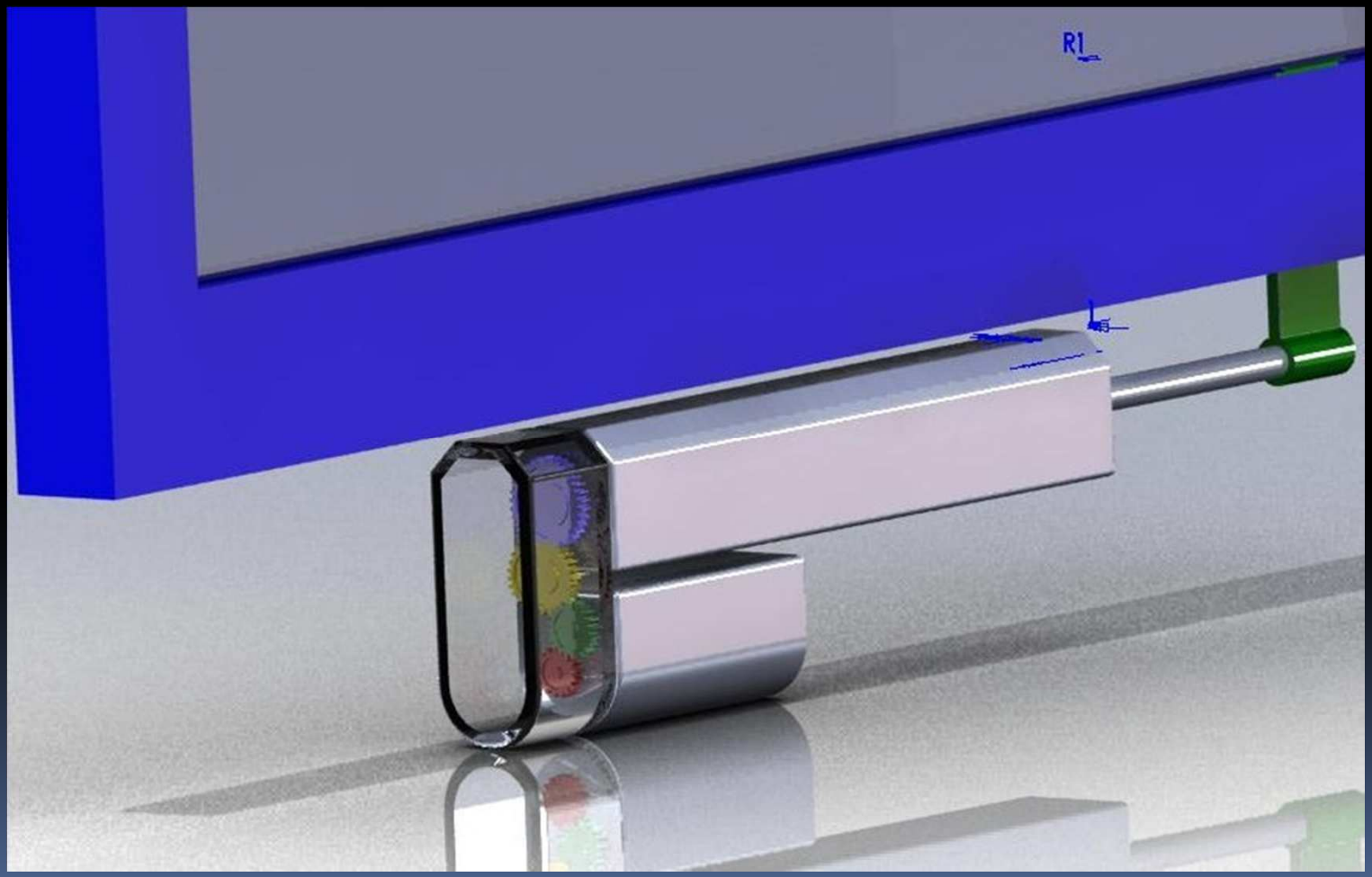




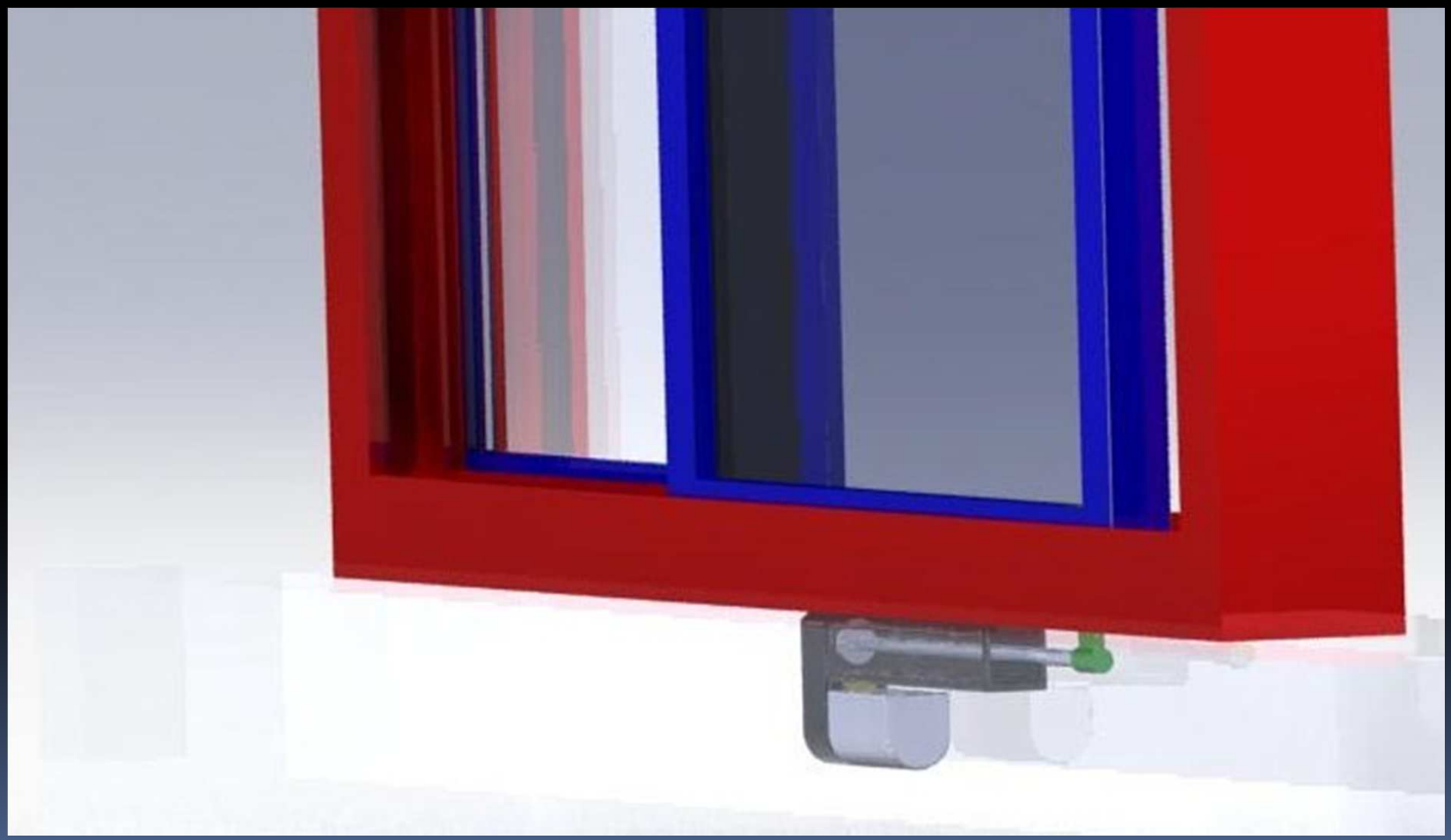
# SolidWorks® design of the Linear Actuator



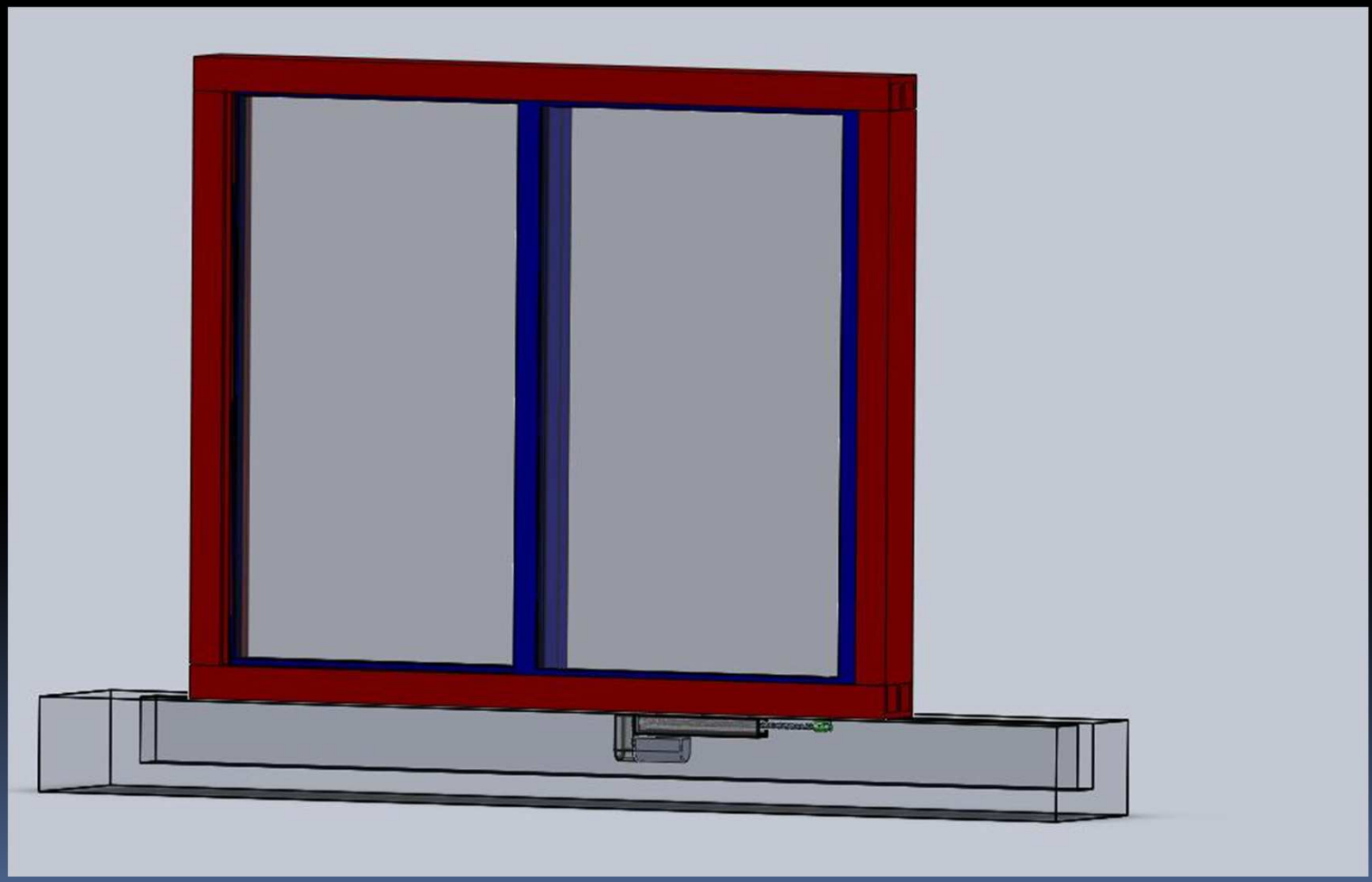
# SolidWorks® design of the final assembly



# SolidWorks® design of the final assembly



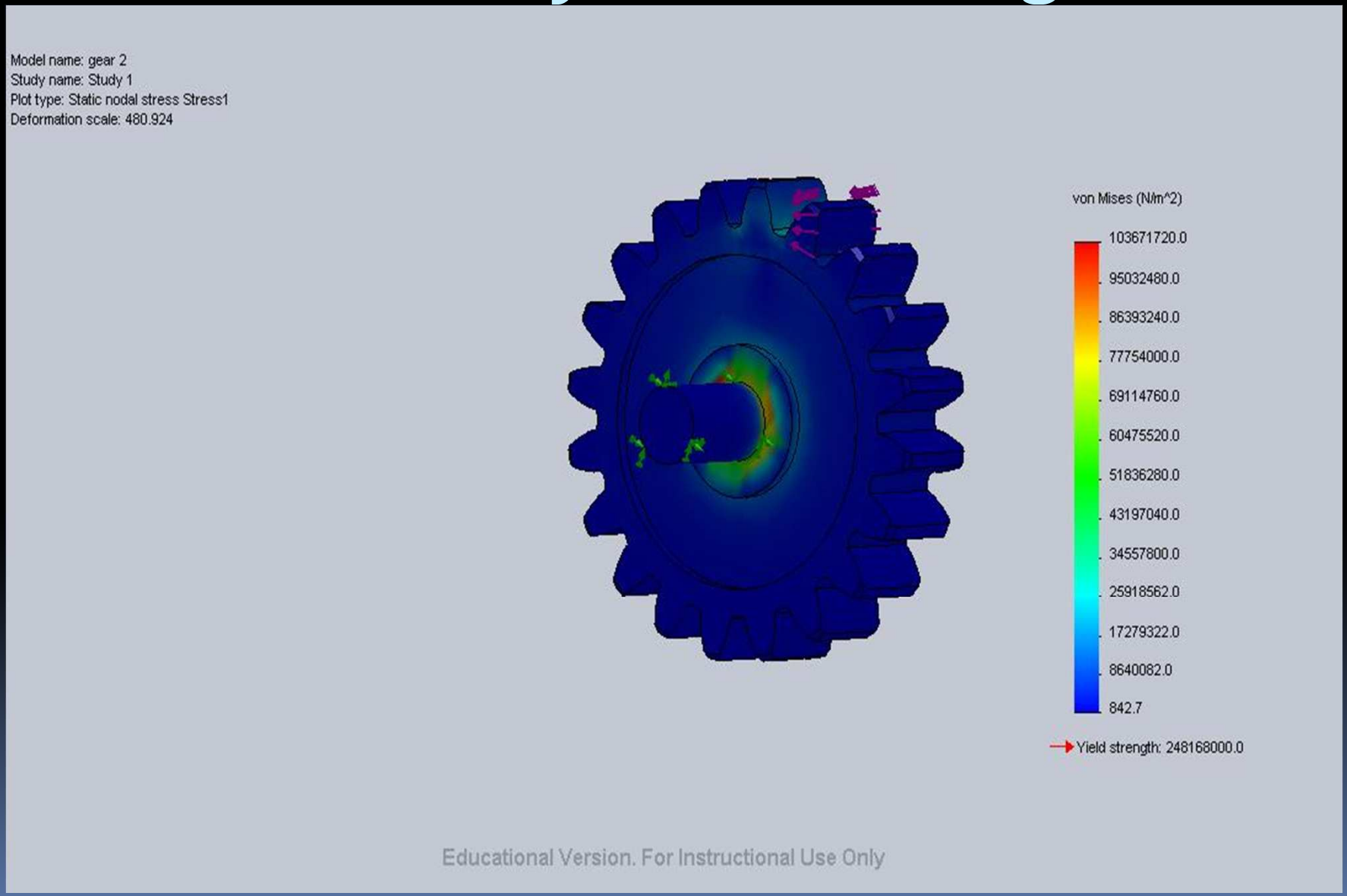
# SolidWorks® design of the final assembly



# Videos...

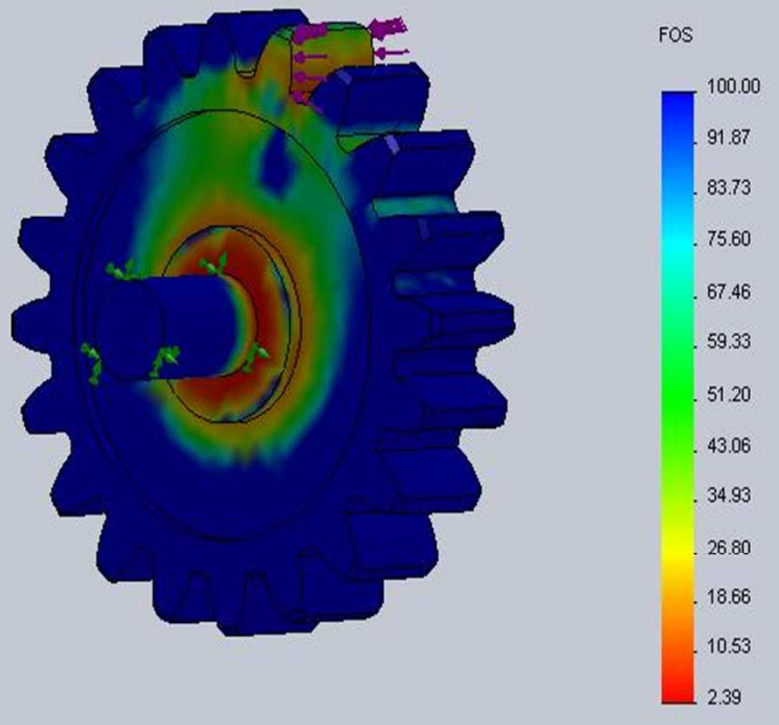
- Linear Actuator
- Linear Actuator (rendered)
- Complete assembly : front view
- Complete assembly : front view (rendered)
- Complete assembly : 3-D view
- Complete assembly : 3-D view (rendered)

# Stress analysis for a gear



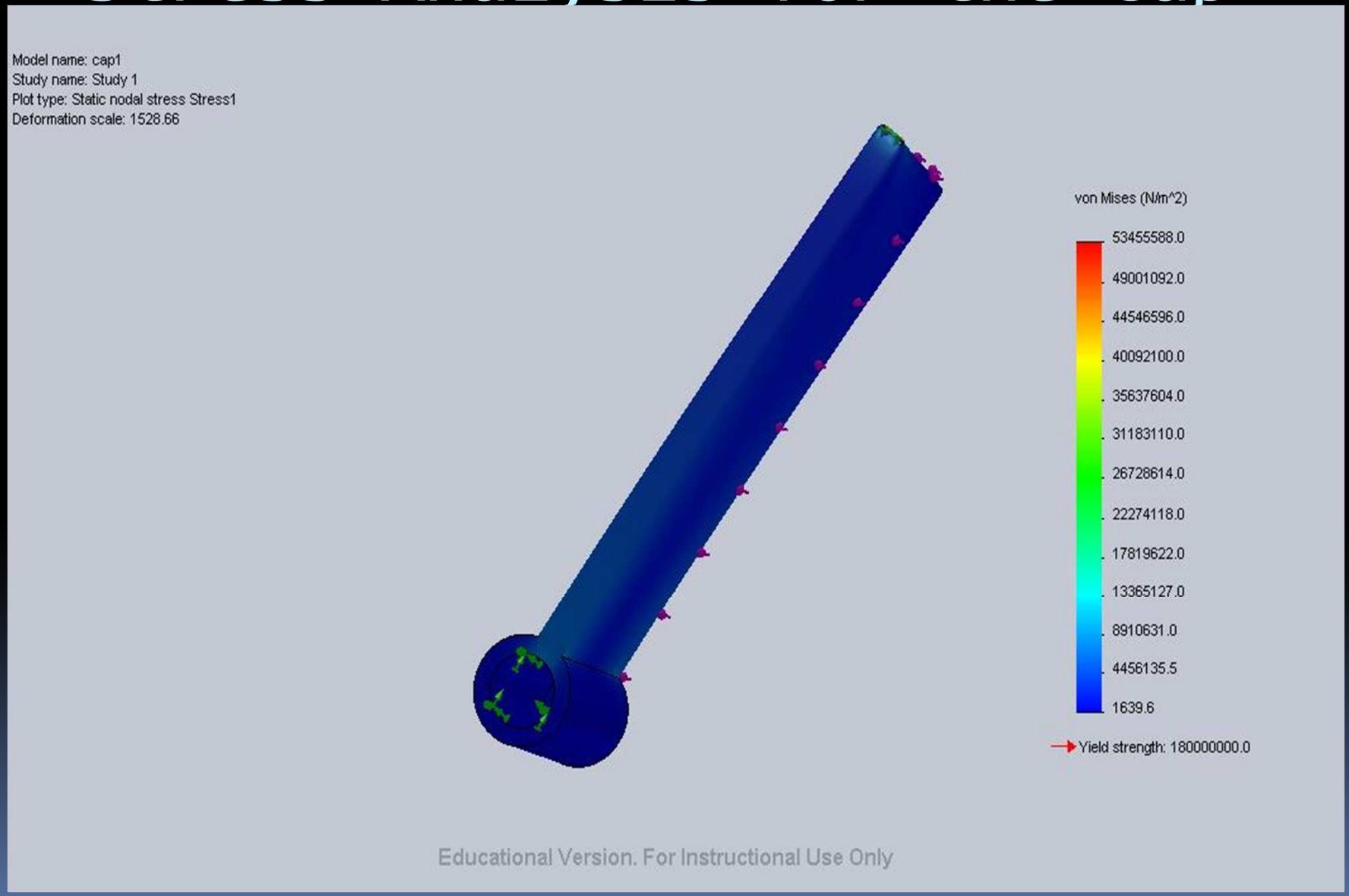
# Factor of Safety

Model name: gear 2
Study name: Study 1
Plot type: Factor of Safety Factor of Safety1
Criterion : Automatic
Factor of safety distribution: Min FOS = 2.4

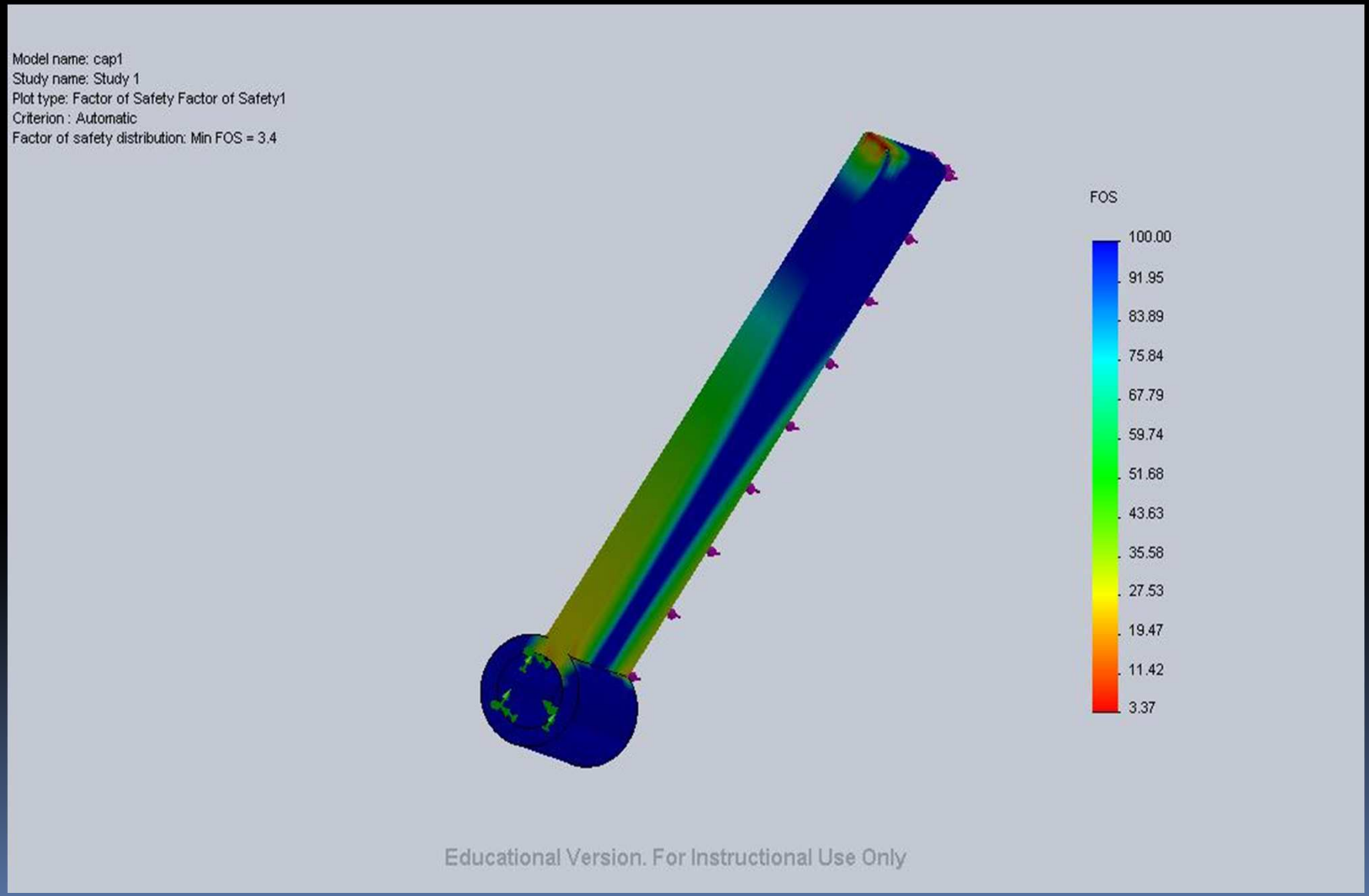



Educational Version. For Instructional Use Only

# Stress Analysis for the cap



# Factor of Safety for the cap



# Patent Search

- Before working on this project, we had gone through www.freepatensonline.com to check if similar products existed. After a lot of research, we came across two products; one of which had a similar aim and the other a similar principle.
- The two most closely resembling patents were:
  - Rain sensor arrangement :United States Patent Application 20070012100
  - Rain sensor car electric closure system :United States Patent 5293105

# Rain sensor arrangement

- Windows in buildings, and in particular in roof windows, are often electrically operated. This allows for easy operation of windows in remote and inaccessible places. Moreover it allows for a window or a number of windows to be automatically operated, e.g. to open if the temperature, the humidity or other parameter in the building, becomes too high. This then may aid in the control of the climate inside the building. Correspondingly a window may automatically close if e.g. the temperature falls below a desired value or if it starts to rain or snow outside.

# Rain sensor arrangement

- This patent mostly talks about the positioning of the rain sensors for this invention and the drawbacks associated with the different positions.
- It talks about placing the sensor outside on top of the window and the disadvantages associated with it.
- It talks about placing the rain sensors inside the building and the disadvantages associated with them.

# Rain sensor car electric closure system

- This invention relates to the closing of an electric car window. Many times it so happens that one leaves electric powered windows of a vehicle down when going indoors; so this invention would automatically close the window when it begins to rain.
- If the windows remain open there can be water damage to the car interior and to things left in the car. Many a car owner has had to run out in the rain to close car windows getting quite wet him in the process.

# Rain sensor car electric closure system

- It makes use of a PNP transistor with a moisture content sensor element interconnecting two electrodes (the emitter and the receiver) of the transistor.
- On wetting, the resistance of the transistor falls down converting into a conductive mode and thus starting to shut the windows.

# Conclusion and limitations.

- We learnt that designing a new product is not an easy task. It requires a lot of rigorous research and calculation.
- Several factors have to be considered and approximations have to be made.
- This has to be a team effort, since an individual only has limited knowledge and experience.

# Conclusion and limitations

- A lot more experience has to be gained before we become professional designers.
- We are totally aware that the project has its weaknesses, but we also feel that it is a healthy design that can be brought into the market after eliminating the limitations.
- The limitation here is the design of the cap and the stroke of the screw.

# Conclusions and limitations

- The design phase was very enjoyable and we did face many problems too. Due to limited availability of time, we couldn't get into more details of the parts.
- We also came to learn more about the computer aided design software of SolidWorks®, which helped us extensively during the course of the project.

# Conclusions and limitations

- We also realized that properly organizing the work and working as a team can help in time management. This can result in more efficient and effective outputs.

# THANK YOU FOR YOUR KIND ATTENTION...