Argon TT

Project in MF2019 - CAD 3D Modelling and Visualization

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Abstract

This report covers the project of 3D modelling and visualizing a record player of model Argon TT. The purpose of the project was to construct a model of a product of choice, and later use the model to run relevant simulations that can be used to base a product analyse. A model of the record player Argon TT, was constructed and used to gain insight in how a record player is structured. The simulations made proved the presumption that a record player is a rather delicate musical tool for sound recreation, and does not get exposed to any big forces when used as it should. The tonearm were assumed to be the most critical component, and were later proven to not be structurally affected.

Contents

1 Introduction

A record player is an apparatus with purpose to reproduce sound from records by sliding a stylus, or needle, along the groove and translate that into a sound signal that can be converted to sounds to listen to with help of a amplifier and speakers. Figure 1 demonstrates how the groove of a record can look like in a microscopic view.

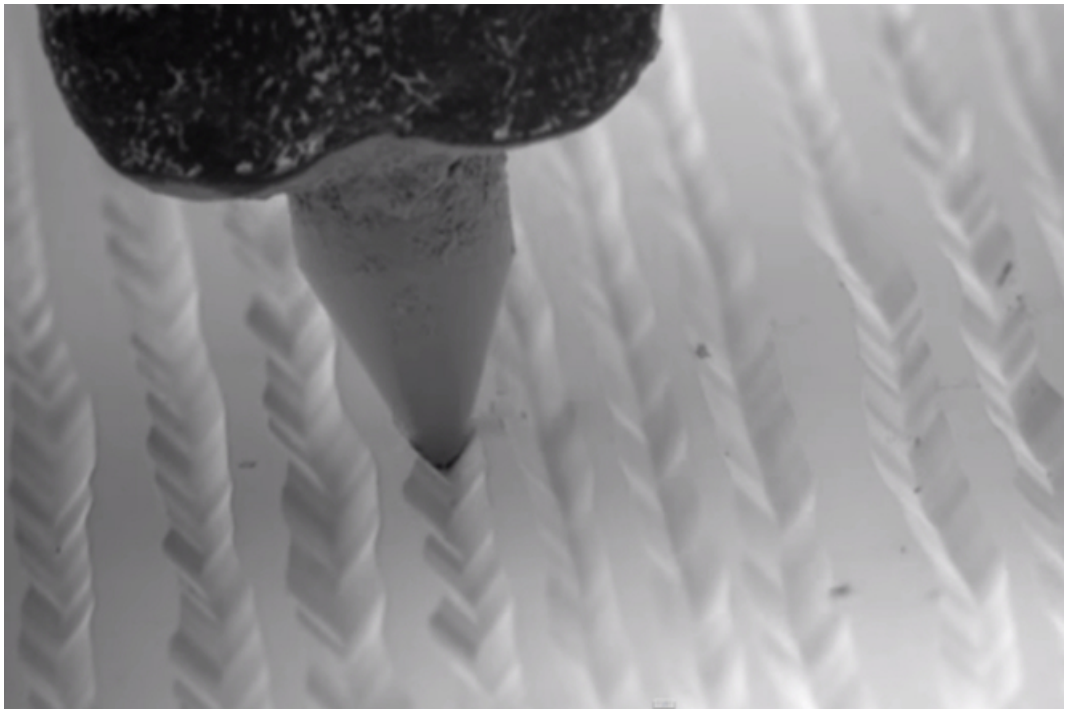

Figure 1: Microscopic view of the grooves of a record together with the top a stylus.

The record player to be modelled is a Argon TT. This exact model is found under the category cheaper record players that still produce high quality sound, i.e. built by cheaper components such as plastic and aluminium instead of carbon fiber and acrylic as in the higher quality record players.

The main purpose of this project is to acquire a greater understanding in the overall structure of the product and investigate mechanisms solely found in similar products. For this reason, general components such as motor and electronic parts is simplified and only modelled for geometric reasons. The same is made for the too advanced components, such as the cartridge that converts vibrations to electrical signals.

Finally, most of the components are modelled to be identical with the original, i.e. having identical measurements and geometric form. However, some components, such as the cover and plinth, are redesigned for aesthetic purpose.

2 Full Assembly

The record player can be divided into six subsystems, starting from the top in figure 2:

- Cover
- Turntable and spindle
- Tonearm and cartridge
- Motor
- Plinth
- Electronics

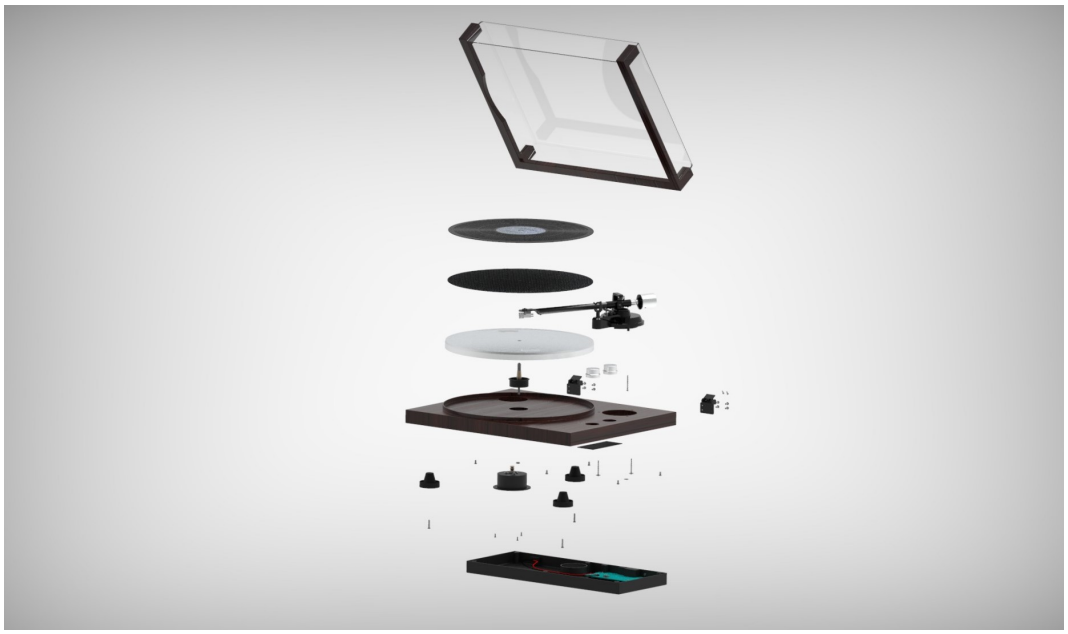

Figure 2: Exploded view of the full assembly.

The plinth is seen as the grounding part in which the other subsystems is attached to. Standard ISO screws, washers, and bolts are used to attach most of the components in the full assembly.

3 Cover

3.1 Function

The purpose of the cover is purely to make sure that delicate components of the rest of the player are covered from dust or other exposure that could potentially do damage.

3.2 Design

The cover is the part that was initially most interesting to redesign. The original design was considered unappealing. Therefore, a frame like part is added that match with the plinth to make a subjectively more appealing look, see figure 3.

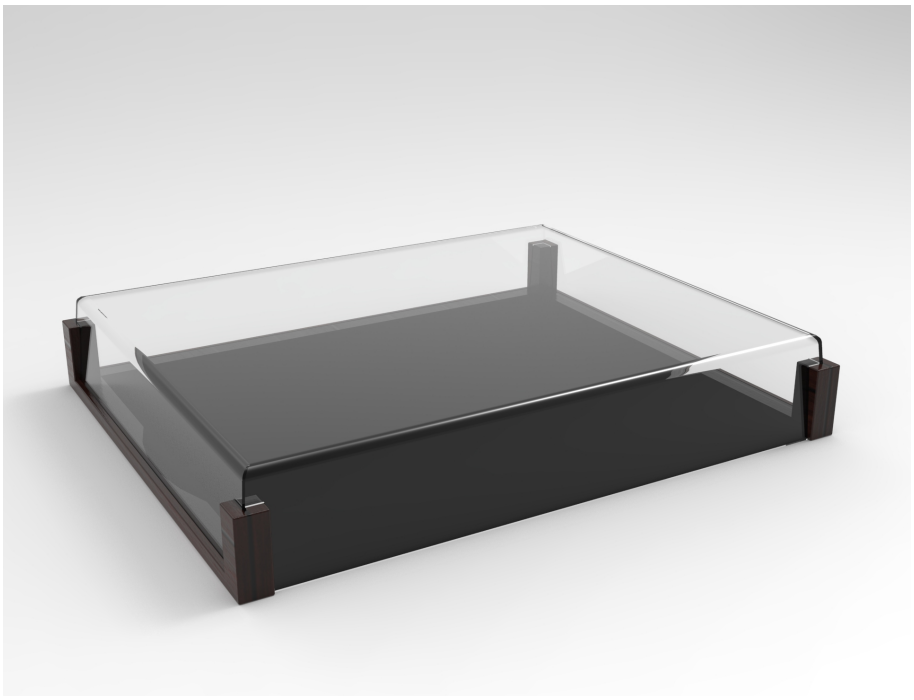

Figure 3: Final design of the cover.

4 Turntable and spindle

4.1 Function

The turntable exists of the parts that holds the record and causing the record to spin. The record is nowhere attached to the player but instead the rotational force is applied through friction from the turntable in which it is placed on. The turntable in itself is belt driven with a source from the motor. The belt is placed on the inside circular wall and is here also dependent on friction.

The spindle is the centering part that holds the turntable in place and makes sure that the turntable is free from any large rotational frictions.

A record is added on top of the turntable with a cloth cover that protects the record from the metallic surface of the turntable.

4.2 Design

It is extremely important that the record that is placed on the turntable rotate in a symmetrical circular way with a constant velocity in order to produce a high quality sound. It is therefore important that the geometry of this part have the right measurements. This is the reason for the relatively small tolerances in the 2D draft of the turntable, shown in appendix A. It is also important that the turntable have a low weight, for it to have a low impact on the rotational velocity, while also maintaining its structural integrity. For that reason, aluminium 1060 was chosen to be a suitable material for the turntable.

The spindle exists of a sort of ball bearing in order the minimize rotational friction, see figure 4. As seen in top of the same figure, the connection between the turntable and the spindle builds on a wedge-like link, where the gravity is the applied force keeping them connected.

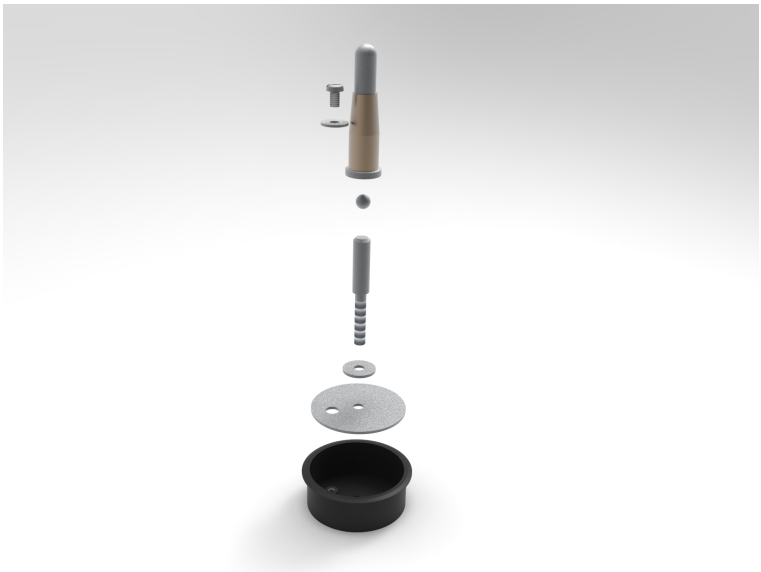

Figure 4: Exploded view of the spindle.

5 Tonearm and cartridge

5.1 Function

The tonearm, and especially the base that holds it is probably the most geometrically advanced, or complex, part of the player. The function of the tonearm arm is to align the stylus in such a way that it follows the groove of the record, and always doing so parallel to the groove.

The tonearm is attach to a base that give the tonearm a freedom of rotation, both up/down and side to side, see figure 5. Since the attachment is with a distance from the edge of the tonearm, a counterweight can be added on the other edge of the tonearm. This weight is attached on a screw, enabling to control the weight applied on the record, see figure 6.

The base consists of a lever that can be used to lift and lower the tonearm, eliminating the risk that the stylus falls down on the record, causing damage on the record as well as the stylus itself. A kind of lock for the tonearm is also added as a security measure when the player is not used.

The cartridge, at the end of the tonearm, is as mentioned simplified because of its severe complexity and merely used as a geometric entity.

Figure 5: Exploded view of the base for the tonearm.

5.2 Design

The tonearm of a record player usually have either a S-shaped form or a straight form. After some research, it was discovered that the straight form is to prefer due to its lower weight and therefore better sound performance, and that the S-shaped form is more used for aesthetic purpose. At the same time as the S-shaped form would be to prefer because this very reason, the straight form was chosen for its less complex geometry. The higher weight is compensated by choosing aluminium 1060 as material.

A majority of the components in the base is made of ABS-plastic.

Figure 6: Exploded view of the tonearm.

6 Motor

6.1 Function

As previously mentioned, the purpose of the motor is to drive a belt that is in itself attached around the turntable and thus causing it to rotate. For this very model, the motor is attached to surrounding cup with three distances made out of rubber in order to minimize vibrations that cause a negative effect on the sound.

6.2 Design

The motor is not a component of interest and is therefore simplified. How the parts surrounding the motor is attached can be seen in figure 7.

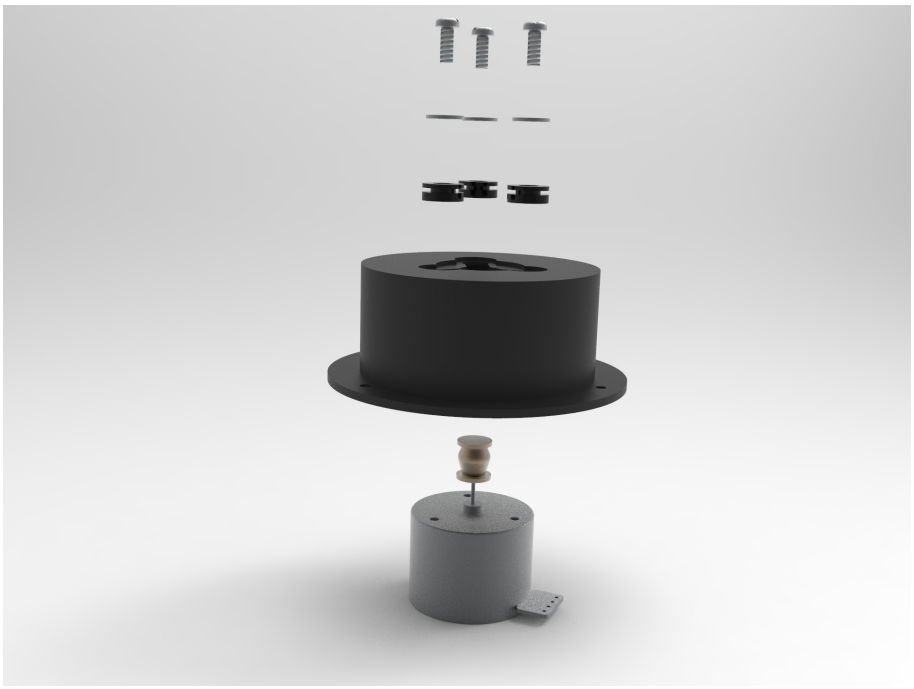

Figure 7: Exploded view of the motor.

7 Plinth

7.1 Function

The plinth have a very simple function but have a large impact on the sound quality. It should partly be a part that the rest of the components can be attached to, but it should also make sure that all vibrations received from either the speakers itself or the piece of furniture that it stands on, are reduced as much as possible. These vibrations can cause the stylus to take up wrong vibrations and in this way cause missound. This is the purpose of the plinth and its feet.

Two controls are attached to the plinth, controlling start/stop and rotation velocity 45/33 rpm.

7.2 Design

The plinth needs to be heavy, and in such way reduce the vibrations, as well as easy to attach components to. Therefore, mahogany is chosen as material for the plinth. The three feet are made out of rubber, in order to reduce the vibrations from the ground, see figure 8.

A small wall is added on the top of the plinth with purpose to cover the gap between the turntable and the plinth.

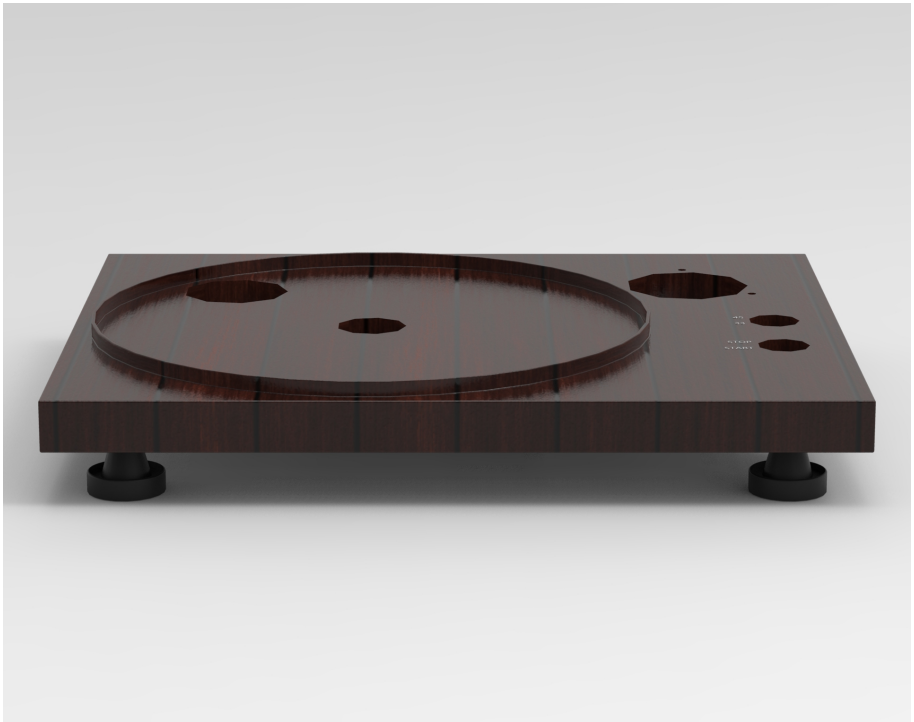

Figure 8: Figure of plinth with three rubber feet.

8 Electronics

8.1 Function

Below the plinth is a shell attached, containing the electronic parts for the player. That implicate inputs and outputs, such as power and signal connectors, as well as a power switch and wiring, see figure 9. A motherboard controlling the player can also be found inside this.

8.2 Design

This subsystem is not of interest more than for aesthetic purpose.

Figure 9: Backside of the player, showing the shell containing electronics.

8.3 Harness

Two wires are attached from the motherboard to the power switch. More wires exists in the original player, e.g. to the controls and tonearm.

Figure 10: Inside of the electronics shell.

9 Analysis

9.1 Motion

Two different motion animations is attached in the submission. The first one, labeled "Open", demonstrate the first step in using the player, i.e. having the player closed, the lid opens and showing the rest of the player. The cover is attached to the plinth with two hinges that in this animation rotates and causing the cover to open.

The second one, labeled "Play", demonstrate the start of the turntable and showing the record spinning with the cartridge placed on it. The turntable that causes the record to spin is rotating with a velocity of 270 deg/s, i.e. 45 rpm.

9.2 FEA - Finite Element Analysis

The stylus is the most critical component that is affected by the largest amount of stress. Since its geometrical complexity, it was chosen to ignore. Instead a finite element analysis (FEA) was chosen to be performed on the tonearm.

The tonearm will be affected by the gravitational force by the two ends, one where the weight is placed, and one where the cartridge is placed. When adding a fixed point at the attachment with the base, and adding gravitational force to affect the object, it showed that the maximal stress can be considered negligible, see figure 11.

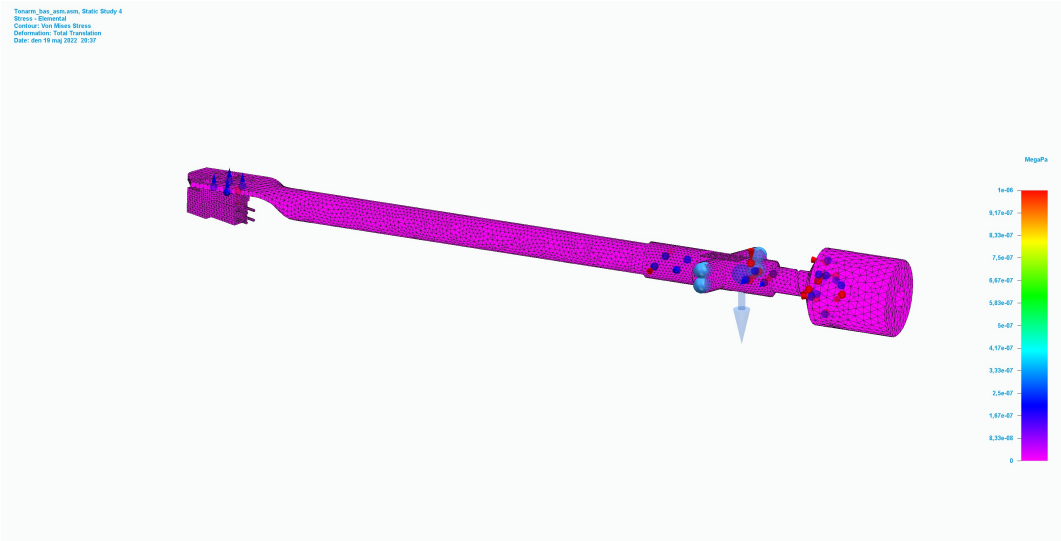

Figure 11: Inside of the electronics shell.

A situation where the user accidentally uses the tonearm with a large force where later investigated. Here it was discovered that when adding a force as large as 1 N, the tonearm gets affected by a stress below its yield stress (12,6 MPa ¡ 31,6 MPa for ABS-plastic) and will therefore hold for large part of extreme situations, see figure 12. The part that will reach breaking point the first was discovered to be near the hole where it is attached to the center arm, see figure 13.

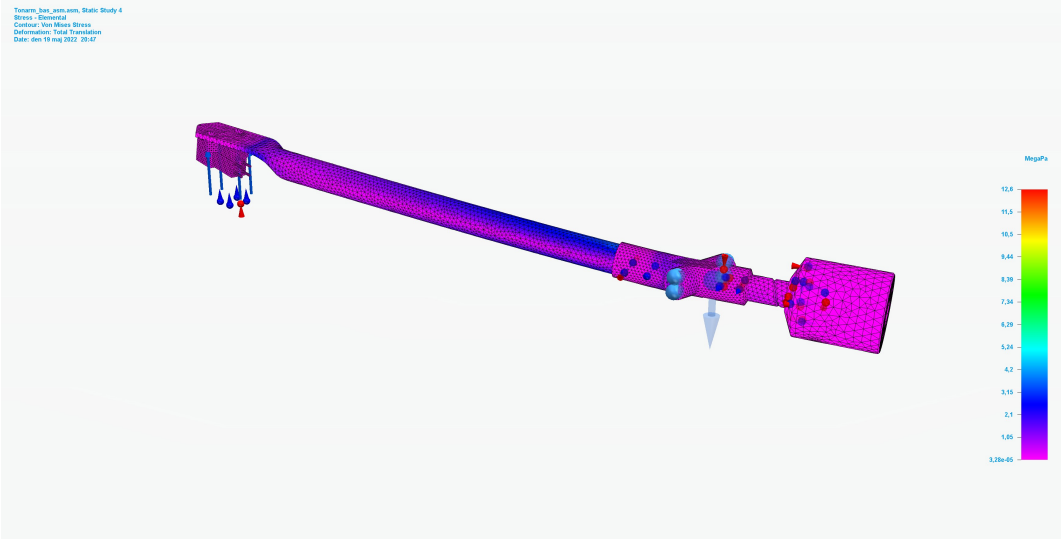

Figure 12: Inside of the electronics shell.

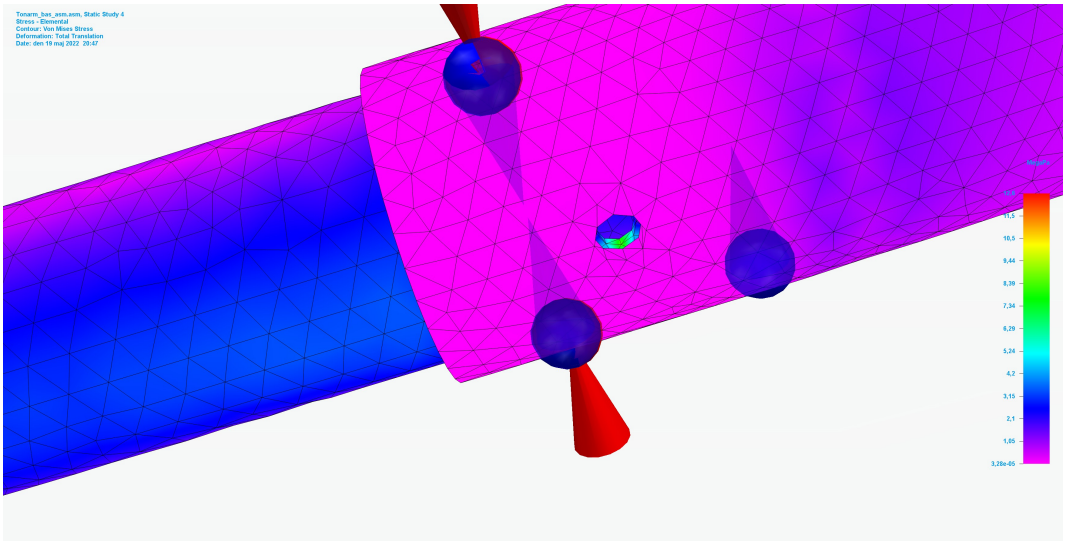

Figure 13: Inside of the electronics shell.

10 Discussion

The intention with the project was to model and visualize a product using reversed engineering. The mission to recreate a convincingly similar model is seen as a success, and almost all of the components that were intended to built, were built without simplifying. The final full assembly consists of 12 subassemblies, 119 total parts, and exist of 68 unique parts. The weight of the record player is 4.977 kg, and the weight of the original have a weight of 4.8 kg. This result seems to indicate that model is a relatively good recreation of the true product.

One other mission was to try to design a more appealing cover that does not just exist of a transparent plastic box. This part could also be developed further by designing a larger amount of sketches. However, the final result is seen as somewhat accomplished.

There is still room for future work in form of more analyses and animations that initially were planned to perform. Some mechanisms that were simplified could be investigated and develop further. The stylus is such a part that was initially planned to be investigated further, but due to lack of time and due to the complexity of the component, the decision to ignore this investigation was done.

Appendices

A Turntable

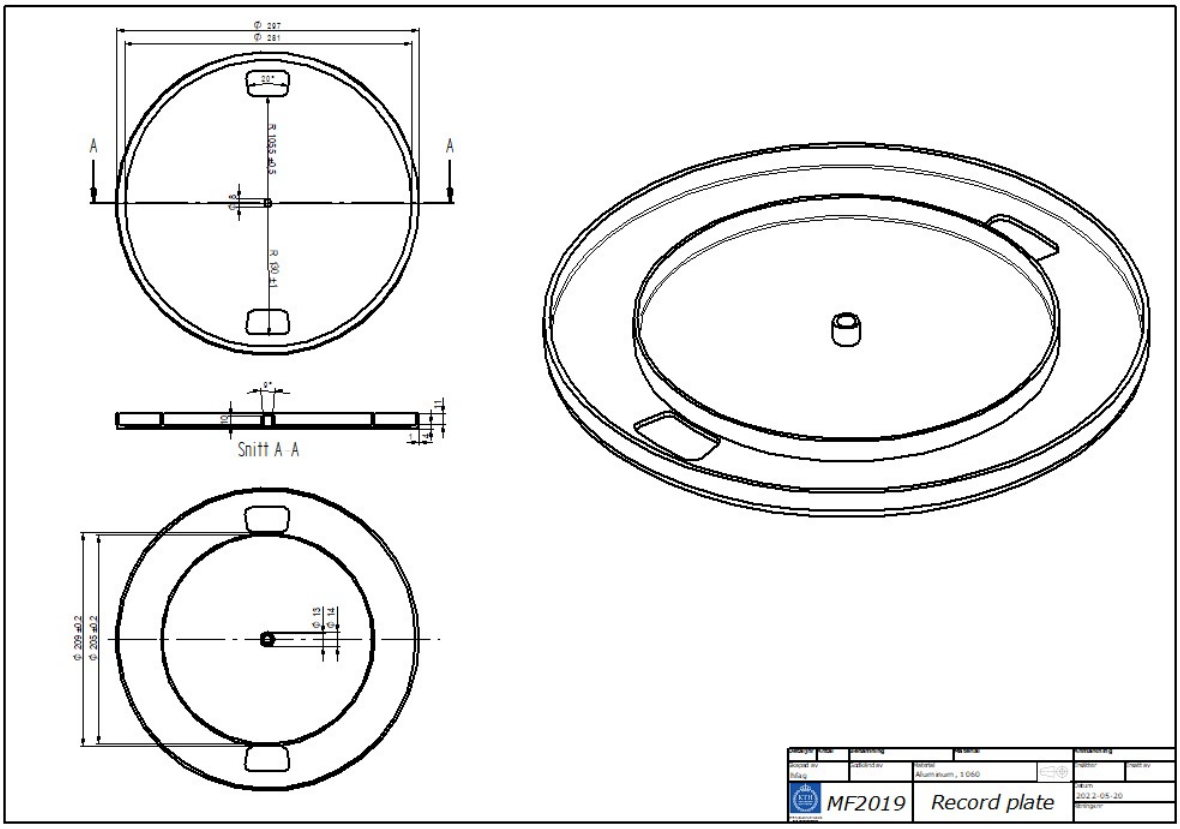

Figure 14: Draft of turntable.