(Above) BEVerage

INTRODUCTION

Who are you and who did you work with?

Our project team consists of seven motivated students from different technical disciplines, collaborating on the development of a thermal system for an electric vehicle.

Team composition:

- Automotive Engineering: Ieke Diever, Mike Markestein and Gerwen van der Gaast.
- Embedded Systems Engineering: Robert-Mihaita Constantin and Justin van der Lee.
- Mechanical Engineering: Gourav Nain and Sam van der Poel.

We were guided and supported by senior engineer Yohann Payet, who provided technical oversight throughout the project.

Our client is N.R.F. (Nederlandse Radiateuren Fabriek), a company in the field of thermal management systems. With over 90 years of experience, NRF develops and produces radiators, intercoolers, oil coolers and condensers for marine, automotive, railway and industrial purposes. NRF is known for its high-quality thermal products.

Client representative: Edwin Kemper (Powertrain specialist)

Project experts:

- Artur Vaanhold (Mechanical Engineering)
- Peter Bijl (Embedded Systems Engineering)
- Bas ter Horst (Power train)
- Frank Berndsen (Vehicle Electronic)
- Nijs van der Mei (Vehicle Dynamics)
- Edwin Kemper (Power train)

Together, this diverse and experienced team made it possible to tackle the project from multiple technical angles and deliver a great result for NRF.

NRF wants to produce after-market parts for thermal systems in battery electric vehicles. To do this effectively, NRF wants to have a simulation model to get a better understanding of how the parts work and their influence on the thermal system.

Electric vehicles are still relatively new compared to internal combustion engines. This implies that many aspects of electric vehicles remain unknown or poorly understood. One such area is about thermal dynamics related to maintaining optimal range, efficiency, longevity, and performance. This topic is of significant interest in the automotive industry and plays a crucial role in developing more sustainable cars in the future. Researching the individual components of the thermal system for NRF provided us with the chance to investigate this matter for ourselves.

JOURNEY & LEARNINGS

During the beginning of our project, we really struggled to get started on the project itself. It wasn't clear what the client wanted from us, and we felt like we were achieving nothing. That slowly changed when we started to figure out what we needed to reach our goal and started working towards it. One of our side projects, an OBD logging tool, started out as a great idea which showed real potential. Everybody was interested, and we were pretty invested in making it work properly. Unfortunately, the limitations of our Opel Mokka test car meant that it wasn't possible to finish this tool, and we had to find another solution to our problem. Luckily, we had other tools to fall back on, and it was easy to get back on track regarding gathering important test data.]

It's moments like finding out the OBD tool wasn't going to work, or when connecting sensors or getting the car up on the dyno and starting testing which have really stuck with us and changed the way we think about our work. Before you start with projects like that, you oftentimes forget how much work it is to make sure everything during testing goes to plan. You may not deviate from the test plans, everything has to be in control, and nothing can be different from last time. Oftentimes stuff happens that you just cannot predict, like the testing equipment suddenly stopping. Luckily, teamwork went well in our group and didn't need any extra effort from the team. What especially stuck with us is how well we adapt to different scenarios and how quickly we can change our strategy when the situation changes.]

OUTCOME & IMPACT

We have been working on 2 main projects that have a direct correlation with each other: analysis and modeling of the cooling system of a BEV (Opel Mokka) and a temperature and pressure data logging tool.

The data logging tool is used to aid in perfecting the models by having a direct real-world comparison. It consists of 12 temperature sensors and 3 probes connected to the pressure sensors of the car. All of them are connected to a microcontroller for monitoring, logging, and displaying data.

This work directly supports NRF's goal of developing high-quality aftermarket thermal components for BEVs. By combining validated simulation models with real-world performance data, NRF gains insight into how individual parts behave under various conditions and how they interact within the complete thermal system. This allows NRF to make more informed design decisions, quicker prototyping, and better prediction of product performance without relying on physical testing.

It also allows NRF to benchmark their aftermarket components against original OEM parts, identify performance gaps or opportunities for improvement, and demonstrate the effectiveness of their products to customers and partners. In a rapidly evolving automotive landscape, this project strengthens NRF’s position as a data-driven, innovation-focused supplier of aftermarket solutions for electric vehicles.

The testing data on the two heat exchangers used within the vehicle’s thermal system also serves as a valuable foundation for future work. It will help the next team or individuals working on this project to develop accurate simulation models of these components as well.

The project still has due elements to reach a satisfactory completion; albeit the work done so far merits a sense of pride and alacrity. We, as a group, had a considerable impediment at the beginning — the paucity of information in last year’s report, which was obsolete to any help it should have elicited. However, we were able to circumvent this unsolicited hurdle with our own inspections and the sagacious guidance bestowed on us by our Senior Engineers. In hindsight, this was an achievement to such an unfathomable extent that we did not even comprehend it properly, for the time was scarce and there were more to come.

Mechanical Engineering: As Mechanical Engineers, we took the initiative to formulate the differential equations for the PTC Water Heater and the Heat Matrix. Not only were the functions of these components complex to fathom — understanding the how the Heat Matrix functions was beyond the periphery of our fundamental knowledge and experience, but little to no information was available about their thermodynamic parameters. Fortunately, constructive feedback and guidance from the Senior Engineers swam us to back to the harbor, which is to say we were on the right path. Few weeks later, our work fructified into what we had expected, and the joy and pride from these results, just like the complexity of the components, were unfathomable.

Embedded System Engineering: As Embedded System engineers, we are proud to have made a working data logging system. This tool can be used to gather data during testing. This data can be used to analyse the car. This information can be used to improve and validate the models of the components. It can also be used to compare the efficiency of different components. In the end, we have a working system that is relatively easy to extend.

Automotive Engineering: As Automotive engineers, we're most proud to show the different regulating systems we've found that the car uses to regulate the temperatures in its systems. Before we started the project, we assumed that a lot of the car's thermal systems would be similar to the ones found in regular combustion cars. However, during our research, we found that this electric Opel Mokka shows a lot of strange behaviour regarding its cooling systems and how they're controlled. While combustion cars have very stable thermal systems, BEVs use complex regulation techniques and are in no way similar to what we were used to. By analysing these systems during our tests, we got a real insight into how BEVs work, and what techniques they use to regulate their temperatures.