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Airless Tire

Workshop & practice (ACHA4011)

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1. Introduction

This report is about exploring and creating an airless tire aka tweel. Airless tires or non-inflated tires are not supported by air pressure, unlike the traditional tire. A solid inner hub connects to the axle, which is encircled by wedge-shaped polyurethane spokes. A shear band is stretched over the spokes to produce the tire's outer edge (the area that makes contact with the road). The strain of the shear band on the spokes, as well as the strength of the spokes themselves, replace traditional tire air pressure. After that, the tread is secured to the shear band. When the Tweel is driven, the spokes absorb road impacts in the same manner as air pressure in pneumatic tires does. The report focuses on the creation of a new airless tire that mainly has a great impact on the environment researched by three teams. Everything, a mankind creates plays a significant role, the beginning of a pneumatic tire was first introduced by Carl Benz in 1888 (Mercedes Benz, n.d.) by the creation of his world-known heritage, the birth of the automobile. Using a solid rubber tire, it is one of the strongest man-made ring-shaped products that surrounds a wheel's rim to transfer cars, motorcycle's and bicycles' load. The purposes of the tires are absorbing the road vibrations, supporting the weight of the car, gives traction and torque (Hankook, 2018).

2. Research

According to the Triad team model Drumond (2019) suggests in order to create a team structure in the aspect of developing a product, it consists of Engineering, Design, and Product teams. From the perspective of a leader, our product, an airless tire is a new concept in comparison to its traditional versions such as pneumatic tires. Following the growth of our new project, we have main four teams. Research and Engineering team, design team, and marketing team.

2.1 Research and Engineering team

The importance of a team focuses on the diversity of thoughts, imagination, and willingness. As part of this project, our research team consisted of 9 people. The 2nd edition of INSPIRED by Cagan, mentions a successful product a customer loves. This has led researchers to focus on the field of performance balance, desired appearance, and customer expected cost. In divisions of three groups of three members each, the research topics were the following.

2.1.1 Appearance and Design

The team worked with the design team in the aspect of material and overall appearance. Fabric, solid rubber, metal, and plastic are the main materials in the designing process.

2.1.2 Performance

According to (Kalahastimath, 2021, p.3), suggests a tweel plays a major role in eliminating air leaks or blowouts. A report (Chillingsworth, 2020) mentions 23 million road users shown underinflated tires are unable to determine what level is too low and 50% ignore it despite its risk of leaks or major blows out.

2.1.3 Cost

With the suggestions of the design and engineering team, the average costing of materials and technology and the marketing has researched on the view of pneumatic tires first. To create a competitive demand in comparison to pneumatic tires, we calculated the average National cost in tires. According to (National Tyres and Autocare, 2021) mentions car tires of Continental, Bridgestone, Pirelli, Barum, and Dunlop. Table 1, consists of tire costs all of which are particularly used in the United Kingdom.

PRODUCT DESCRIPTION	NATIONAL PRICE
<u>Autogreen Sport Chaser SC2 205/55WR16</u>	£51.86
<u>Autogreen Super Sport Chaser SSC5 215/50WR17 XL</u>	£61.10
<u>Avon AV12 235/65R16C</u>	£113.90
<u>Avon ZT7 175/65TR15</u>	£56.21
<u>Avon ZX7 225/55VR18</u>	£106.21
<u>Bridgestone Potenza S001 255/40YR18 BMW RFLAT</u>	£178.37
<u>Bridgestone Potenza Sport 225/45YR17 XL</u>	£85.88
<u>Bridgestone Turanza T005 205/55WR16</u>	£74.17
<u>Continental PremiumContact 6 225/40YR18</u>	£104.27
<u>Dunlop SP Sport BluResponse 185/60HR15</u>	£74.64
<u>Goodyear EfficientGrip 2 225/55VR19 SUV</u>	£127.99
<u>Goodyear EfficientGrip Performance 185/60HR15</u>	£74.22
<u>Pirelli P Zero 255/55WR19 J-LR XL</u>	£127.94
<u>Pirelli Scorpion Verde All Season 235/55VR19 LR XL</u>	£141.98
Total Average	£98.48

Table 1. The average cost of National tires used in the United Kingdom.

2.2 Design team

The combination of tire and wheel has had a significant impact on its evolution. The fundamental basis of creating an airless tire has a similar structure to pneumatic tires. However, single-unit replacing and

valve assembly (Suhag and Dayal, 2013, p. 1-3) creates a new tire replacing all components of a typical radial tire.

A tweel is a kind of airless tire that is purposely designed to eliminate flats and reduce downtime (Nakajima, 2019, p. 8). In comparison to pneumatic tires, it can perform a smooth ride and satisfies to all types of terrain. As a raw 2D design in Figure 1 consists of a metal center, polyurethane balances, and an exterior ring.

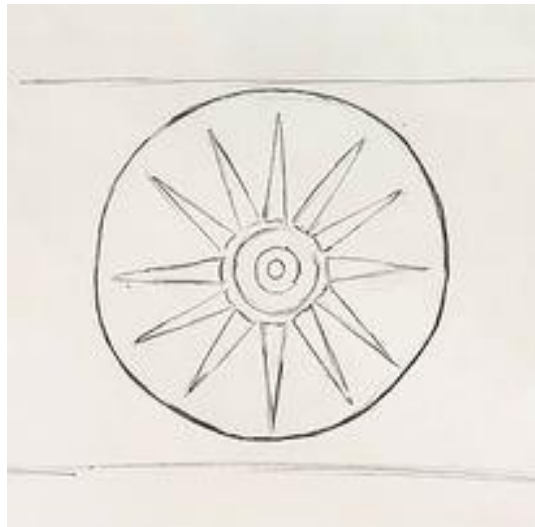


Figure 1. A raw 2D drawing of the design volume 1.

The design allows the tire to avoid the underneath pressure that pneumatic tires require. The layout with superfluous footing is required for terrain with intense surface and asymmetrical route. Its flexible spokes twist and move as a pad; its ability to recover the structure is generally due to the polyurethane material's actuality. Because of its sheer band layout, it brought suspension, and reduced movement blockage, the airless tires promise total performance levels above those achievable with standard pneumatic technology. It has a pneumatic-like burden carrying limit, riding comfort, and cannot be pierced since it lacks a pressurized air cavity.

2.3 Marketing Team

According to (National Tyres and Autocare, 2021) accumulated an average of 98.48£ of the national tire cost of five manufacturers. Using as the fundamental cost, the team sets the profit margin on top of the Ideation process, industrial design, prototyping, certifications & testing, design, manufacturing process, and further handling costs estimates in a total of seventy thousand pounds to two hundred thousand pounds according to (Ferrer, 2008). The team has closely worked with the team leader to understand the process and upcoming of the product. As a product must have successful growth, the team is set to set up business meetings with car dealerships and understands that a market for an airless tire will not stop only in the field of vehicles but all transportations.

3. Methodology

Almost all the passenger cars on the road use non-pneumatic tires and it is the best on the market at the moment but, there are problems with it, such as cracking tire rubber due to heat, misalignment, tire pressure, and punctured tires. The engineering teams have collected the data about airless tires and are able to make the concept that might solve these common problems that inflatable tires. The research and engineering team did research based on appearance and design, performance, and cost. In addition, the design team has been involved with the research and engineering team to find out the average price of the national tires. The design team members had to study the pneumatic tire structure in general and compare the facts of flat tire and tweel. Moreover, sketched the basic design of a non-pneumatic tire which looks like bicycle spokes.

3.1 Product development

The airless tire structure is inspired by a diamond shape and the structure of the spokes looks similar to a honeycomb. Air tire consists of belt, tread, and air-filled volume. Airless tires are similar to pneumatic tires in a way that they transport enormous loads at enormous distortions, however, they are distinct in that they lift huge heaps despite the addition of expansion pressure. While all pneumatic tires of a given size and weight will have almost identical vertical solidity and ground contact pressure, an airless tire's stiffness and contact stress are regulated by a variety of geometric and material characteristics.

3.2 Safety

One of the biggest concerns about the airless tire is safety. As of 2021, non-pneumatic tires are not popular among people and there are no production airless tires available at the moment but, they will be on the market soon and even possibly for better performance and safety than pneumatic tires. Tires are one of the most components of the vehicle and it is the only part that actually touches the ground unless something bad happens. It is clear that airless tires will reduce tire blow-out accidents dramatically and they may last three times more than traditional tires.

4. Discussion

The pneumatic tires came a long way on production cars since 1888 and are still used on most cars on the road today. There are some advantages that really stand up, in particular, pneumatic tires can self-seal with a layer capable of propping up any puncture that appears and prevent any risks such as instant air loss (Tyres Nothampton, 2021). non-pneumatic tires would probably take place and become able to fit any vehicle. Airless tires usually have greater rolling resistance than non-pneumatic tires. Both airless and pneumatic tires will cause damages because too many new tires are produced every day. In order to produce less pollution to the world, less raw materials and chemicals should be used to make the tires moreover it has to be simple to recycle them. The advantages of airless tire are fuel-efficient, reasonable price, less maintenance, smooth ride, and most importantly it eliminates the dangerous risk of flat tires and blowouts that results from punctures or road hazards.

4.1 Environmental impact

Airless tires use less raw materials and power in production, unlike traditional pneumatic tires. The amount of damaged or scrapped tires due to over inflation, heat, water, and potholes will dramatically reduce due to non-pneumatic long-lasting tires. In addition, Tweels would deliver fewer emissions, maintenance, and running costs than pneumatic tires to the vehicle. in order to extend the age of the tire and fewer recourses will be needed to produce airless tires. In fact, car tires are one of the major waste issues. According to Jeremy Williams (2017), approximately 1.5 billion tires are wasted every year. Most of them can be treated and used again but they will tear and wear at some point.

5. Conclusion

The team made long-lasting, environmentally friendly, and durable airless tires. During the development process, the team has required other departments to work with in order to make the product flawless.

The engineers have designed a blade-shaped tweek therefore air can flow through which the tire makes lower turning resistance on the road. The material of the tweek had to be flexible and strong internal centre point that connected onto the shaft of the car that is surrounded by polyurethane spokes. The spokes look similar to the spokes of the bicycle, as a result, the airless tire is smoother and better absorber than pneumatic tires. In the future, non-pneumatic tires might become even more ambitious toward sustainability and mobility for all. As an engineering team leader, working in the electric car industry and long-lasting non-pneumatic tires would be a fantastic combination to work on in the future and it would be more than achieving a goal.

Working as a team leader in the field of creating a new product has in many aspects set a clearer career choice. Automotive engineering of four years, the study of my own choice, circles around three main areas. Design, Production and Development. The combination of engineering and commercial skills to be able to demonstrate clear and effective projects within given budget. As a Level 4 student, I quickly felt the urge to learn and gain more skills and knowledge as there will be many responsibilities or tasks depending on the specialty of my area of work.

Up until now, the knowledge I have learned were only the fundamental basis and yet there are much more to the engineering world. In the next five year I want my career goals to firstly be able to get an internship. In the upcoming summer of 2022, wish lists to be able to take part in NXP USA Inc, in automotive production line.

Other than theories, I believe a great engineer should be well performed in real life scenarios. I believe this internship will be able to enhance further knowledge. Studying in Level 5, I wish to work in a team at the student and lecturers provided projects that runs starting from October, 2022. Continuing and being able to demonstrate a good performance along with identifying solutions this routine will help in my career goals to be a great engineer. Taking every chances along the way.

6. Reference list

Celine, A. (2021) *UPTIS: Michelin Airless Tires Out and About at IAA MOBILITY*. Available at: <https://www.motorbiscuit.com/uptis-michelin-airless-tires-about-iaa-mobility/> (Accessed: 23 November 2021).

Chillingsworth, L. (2020) *Road safety warning: 23 million UK motorists risk dangerous blowouts on 'deadly' tires*. Available at: <https://www.express.co.uk/life-style/cars/1336285/car-tyre-road-safety-warning-blowouts-danger-halfords-underinflated-wheel> (Accessed: 04 November 2021).

Drumond, C. (2019) *How to build a kick-ass agile team*. Available at: <https://www.atlassian.com/agile/teams> (Accessed: 01 November 2021).

Ferrer, G. (2008) 'The Economics of Tire Remanufacturing', 96(39), pp.3-12.

Hankook. (2018) *Functions of Tires*. Available at: <https://www.hankooktire.com/mea-en/services-tips/tire-guide/functions.html#:~:text=Tires%20are%20designed%20to%20support,and%20filled%20with%20compressed%20air> (Accessed: 24 November 2021).

Kalahastimath, A.K. (2021) 'Review on Airless tire' 8(4), pp.2-4.

Mercedes Benz. (n.d.) *Benz-Patent is Part of the World Documentary Heritage*. Available at: <https://www.mercedes-benz.com/en/classic/history/benz-patent-motor-car/> (Accessed: 01 November 2021).

Nakajima, Y. (2019) *Advanced Tire Mechanics*. 1st edn. Singapore: Springer

National Tyres and Autocare (2021) *Compare Tyre Prices*. Available at: <https://www.national.co.uk/price-comparison> (Accessed: 01 November 2021).

Suhag, A. and Dayal, R. (2013) 'Static Analysis on Custom Polyurethane Spokes of Airless Tire', 3(11), pp. 1-3.

Tyres Northampton, (2021) *AIRLESS TYRES: PROS AND CONS*. Available at: <https://www.tyresnorthampton.com/news/airless-tyres-pros-cons/> (Accessed: 28 November 2021).

Williams, J. (2017) *What can the world do with 1.5 billion waste tyres?*. Available at: <https://earthbound.report/2017/06/29/what-can-the-world-do-with-1-5-billion-waste-tyres/#:~:text=Car%20tyres%20are%20a%20major,a%20point%2C%20but%20not%20endlessly>. (Accessed: 22 November 2021).