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## The impact of the 2022 season regulation changes on overtaking in Formula 1

The 2022 season saw an overhaul of the technical regulations to allow drivers to follow each other more closely and improve overtaking. To analyse how successful these changes were, we used the Keberz Engineering overtaking database with over 3,500 overtakes in Formula 1 since 2017.

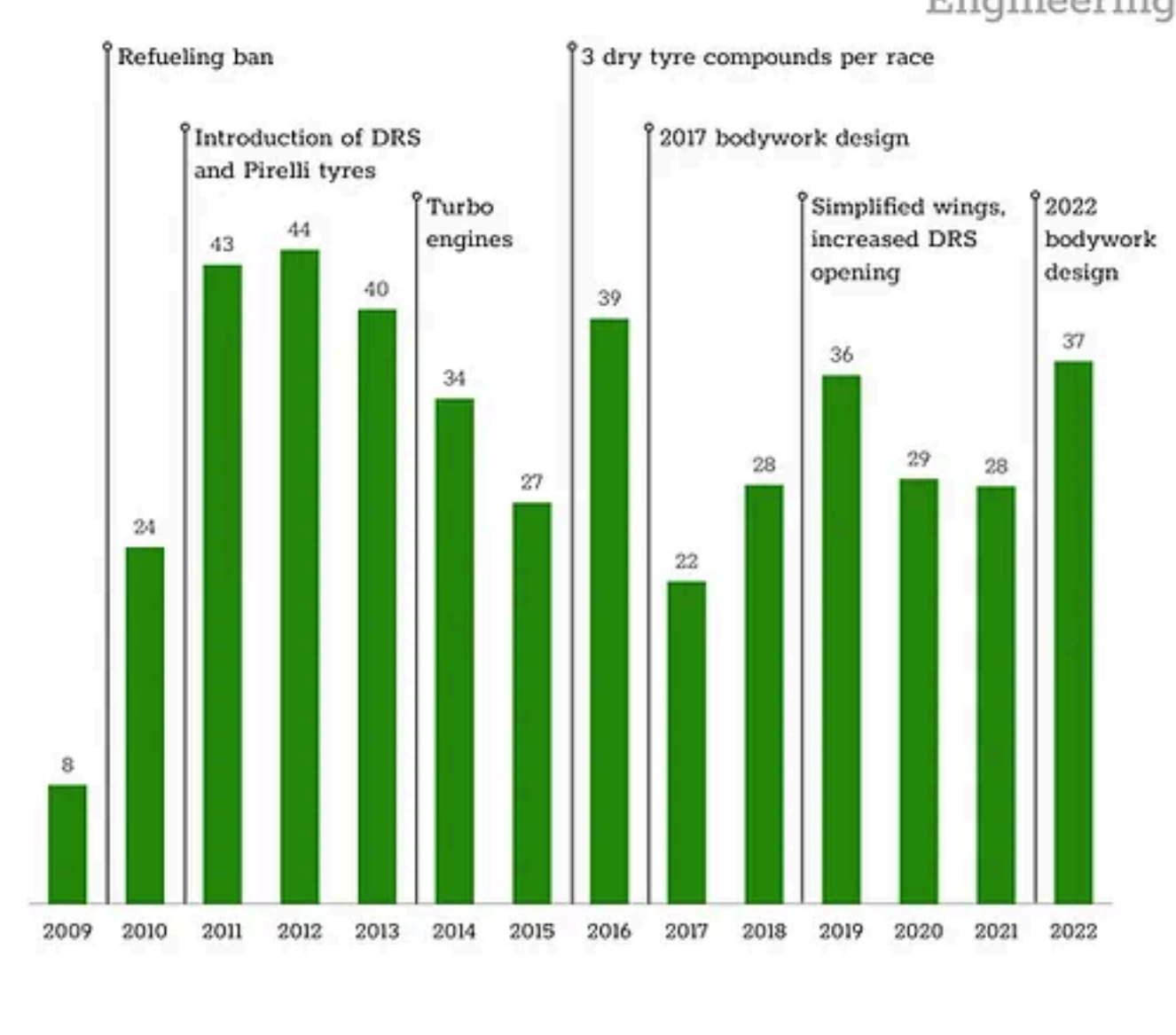
### Insight #1

Overtaking in the 2022 season has become easier, and the average number of overtakes per race increased by 28% relative to the 2017-2021 seasons

The main goal of the changes to aerodynamics and bodywork was to reduce the turbulent air in the wake of the cars to allow drivers to follow each other more closely whilst still maintaining a similar level of downforce compared to previous years, thanks to the ground effect.

The bodywork design included the elimination of bargeboards, simplified front wing and endplates, wider and higher-mounted rear wings and additional restrictions to limit the constructors' ability to use a car's exhaust gases to generate downforce.

Figures released by the Working Group revealed that where a 2019-specification car following another car had just 55% of its regular levels of downforce available, a 2022-specification car following another car would have up to 86% of its regular levels of downforce.



Note: Included any change in track position under normal racing conditions, excluding position changes: during the first lap of a race or during the first lap after a standing restart; in the pits; due to driver errors, crashes, penalties or mechanical issues; due to team or race direction orders; against lapped cars.

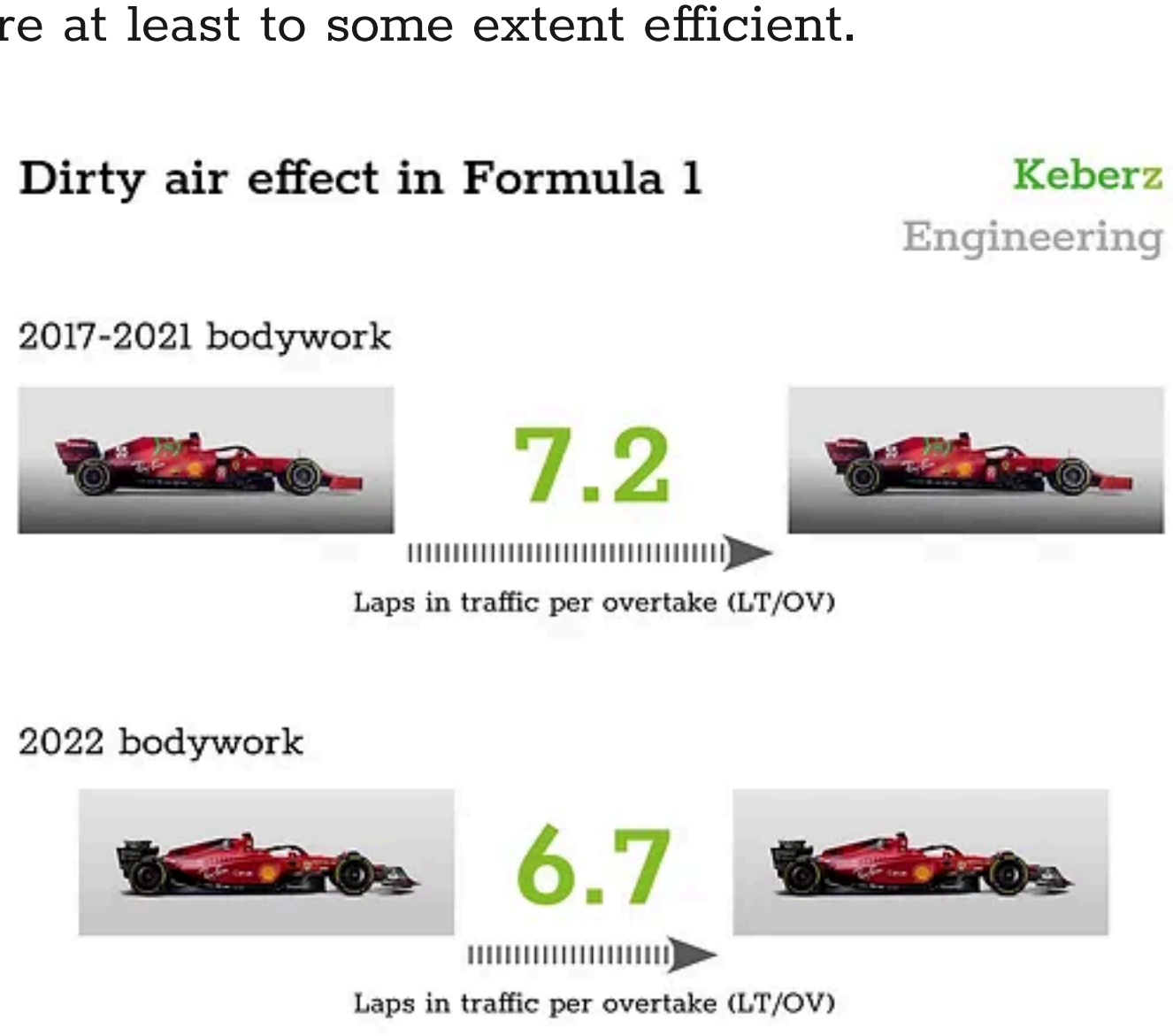
These changes reduced dirty air and made overtaking simpler. However, the overall impact was less severe than in 2011 with the introduction of DRS. The average number of overtakes increased to 37 per race, or 28% relative to the 2017-2021 season average. The 2022 season was only the fourth season in F1 history with over 800 on-track overtakes (others are 2011, 2012 and 2016).

### Insight #2

The regulations reduced the impact of dirty air, and cars could follow each other more easily - the average number of laps to make an overtake decreased from 7.2 in 2017-2021 to 6.7 in 2022

To measure how difficult it is to follow cars in dirty air, we collected data on the number of laps in traffic and the number of on-track overtakes during all seasons since 2017. Each vehicle's lap was counted as "in traffic" if a car was less than a second behind the next non-lapped car at the start-finish line.

In the 2022 season, the average number of laps per overtake decreased by 7% relative to the 2017-2021 seasons (6.7 vs 7.2 laps). It implies the new aero and bodywork regulations introduced to reduce the loss of downforce in dirty air were at least to some extent efficient.



With only one season completed under the new regulations, the data on individual circuits is still quite volatile. Still, the relative impact was more severe for courses suitable for overtaking.

For instance, laps in traffic per overtake at Bahrain International Circuit, Circuit of the Americas, Spa and Interlagos dropped by 10-15%, while in less favourable for overtaking Red Bull Ring, Silverstone and Monza, it reduced only by 5-10%.

### Insight #3

The difference in performance, tyre wear, and DRS are all significant contributors to overtaking in Formula 1, with DRS enabling almost every fourth overtake

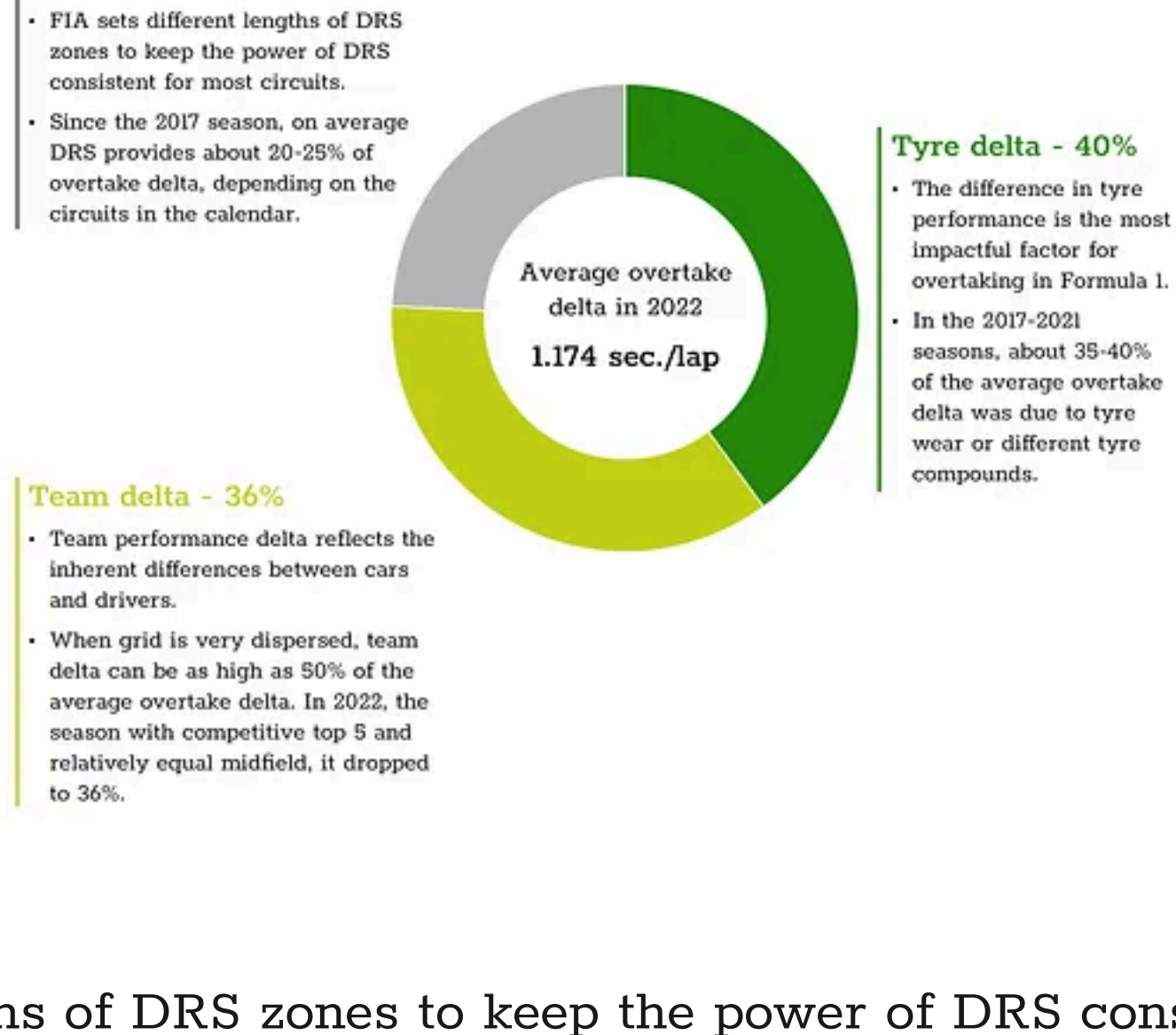
Overtake delta shows how much faster, on average, in terms of seconds per lap, the car behind has to drive to overtake on a particular circuit.

For every overtake, we calculated the delta as the sum of 3 components:

- Team performance delta is measured as the difference between the best qualifying lap times for the teams involved in an overtake;
- Tyre delta is measured as the difference between benchmark lap times set by identical cars on the corresponding points of tyre degradation curves;
- The DRS effect is the approximate reduction of lap time due to the increased speed in the DRS zone used for an overtake.

The average overtake delta is calculated for all overtakes during the season. During wet sessions, some components can be missing due to the lack of consistent data for the model.

For the 2022 season, the average delta was about 1.2 seconds for a 5 km lap. The range was between 0.5 seconds per lap in the Miami GP and 3.7 seconds per lap in the Singapore GP (the race in Monaco had too few overtakes). The structure of overtake delta has remained the same since the 2017 season.



#### DRS (24%):

- FIA sets different lengths of DRS zones to keep the power of DRS consistent for most circuits.
- Since the 2017 season, on average, DRS provides about 20-25% of overtake delta, depending on the circuits in the calendar.

#### Tyre delta (40%):

- The difference in tyre performance is the most impactful factor for overtaking in Formula 1.
- In the 2017-2021 seasons, about 35-40% of the average overtake delta was due to wear or different tyre compounds.

#### Team delta (36%):

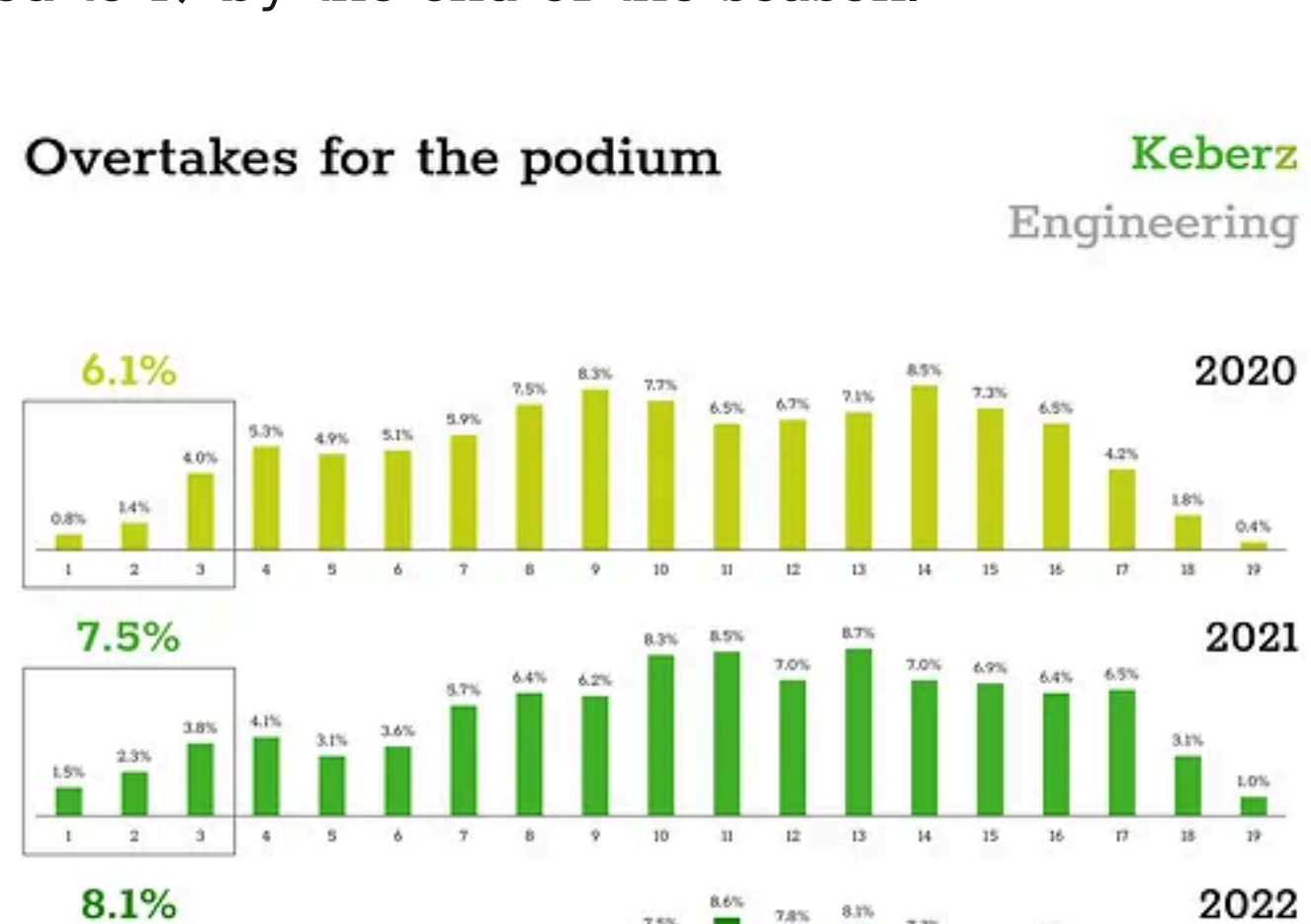
- Team performance delta reflects the inherent differences between cars and drivers.
- Team delta can be as high as 50% of the average overtake delta when the grid is very dispersed. In 2022, the season with a competitive top 5 and relatively equal midfield, it dropped to 36%.

### Insight #4

The 2022 season had more overtakes for the lead and podium positions than other recent seasons, despite a dominant win by Verstappen in the drivers' championship

Teams in the upper midfield usually make the highest number of overtakes. Alpine (103 overtakes), Ferrari (99 overtakes) and Mercedes (96 overtakes) were the top overtaking teams this season. The championship-winning Red Bull spent plenty of time in the lead and scored 85 overtakes.

Overtakes for the lead remain a rare occurrence in Formula 1. In 2020, drivers made only five on-track overtakes for P1 - the worst recent season in recent history by this metric. In the first half of the 2022 season, the closely matched Ferrari and Red Bull produced a few exciting races, and the total number of overtakes for the lead climbed to 19 by the end of the season.

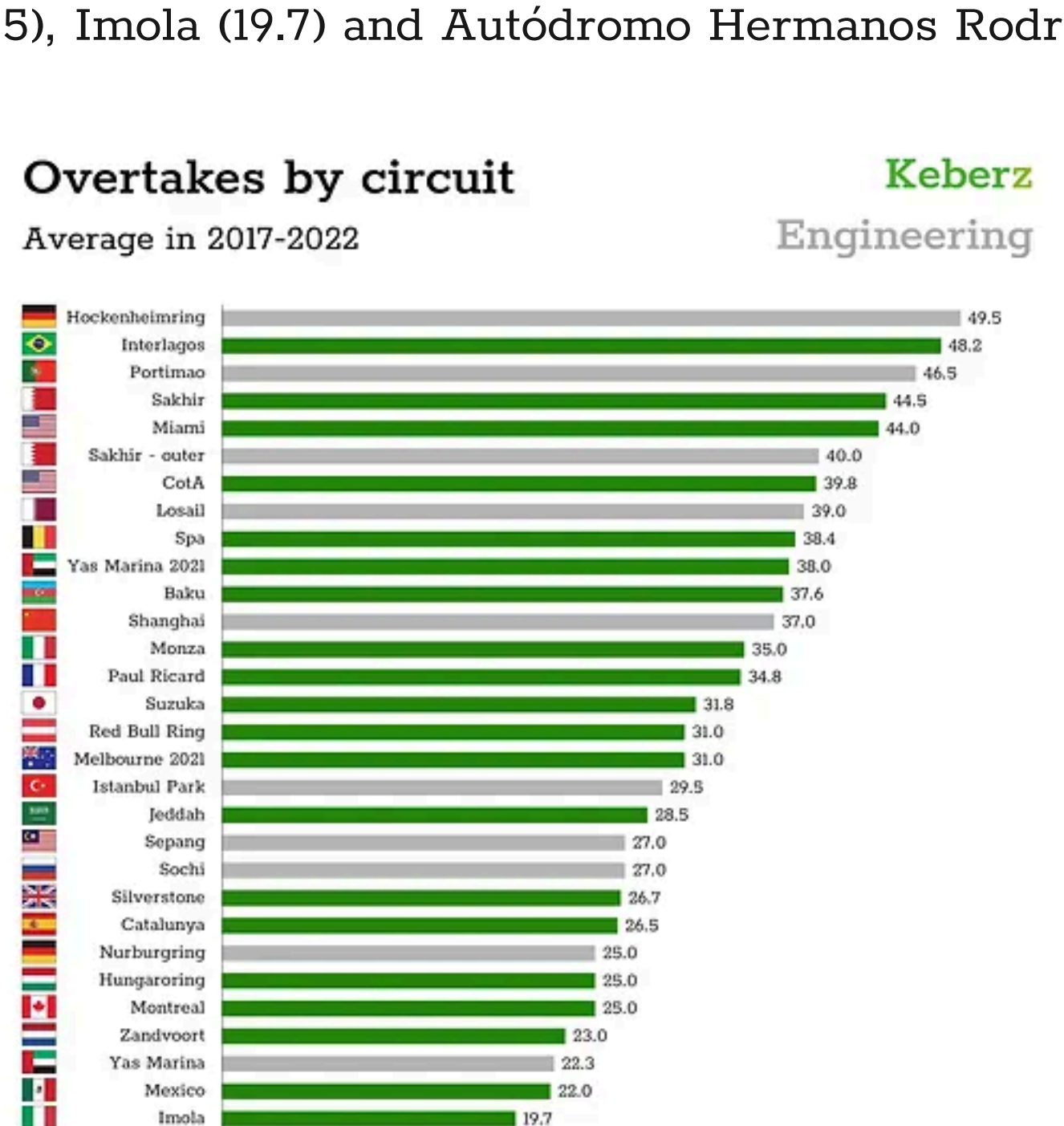


### Insight #5

Interlagos was the best circuit for overtaking in the 2022 calendar, with an average of 48.2 overtakes per race during six recent seasons

In 2017-2022, 123 Formula 1 races were held on 31 different circuits (or 34 unique layouts, including Bahrain Outer Circuit and the new layouts of Yas Marina and Albert Park Circuit).

The most overtakes were made on Hockenheimring (49.5 overtakes per race on average), Interlagos (48.2) and Portimão (46.5). The bottom three circuits are Monaco (4.0), the old layout of Albert Park Circuit (5.7) and Mugello (18.0). Other notable circuits with a low number of overtakes per race are Marina Bay Singapore (19.5), Imola (19.7) and Autódromo Hermanos Rodríguez in Mexico (22.0).



Of course, the number of overtakes for a specific circuit depends on multiple factors.

- Some factors are intrinsic to the circuit, like the layout or the rate of tyre wear. Others are race-specific, such as the alignment of the starting order to the actual pecking order of cars (recently, this aspects a significant factor with "tactical" grid penalties taken for new power units). Finally, some aspects can be adjusted by the series management, for example, available tyre compounds and the length of DRS zones.
- Our analysis and race simulations show that for most circuits, the average number of overtakes per race can be moved by 5-10 overtakes up or down just by the changes in this final group of factors.

### New circuits and layouts

In the 2022 season, Formula 1 introduced one new circuit (Miami) and one new layout (Albert Park in Melbourne) to the calendar. Both turned out to be good for overtaking.

Albert Park went from being one of the worst circuits for overtaking to the middle of the pack with 31 overtakes. With two long straights and over 40% of the circuit length under DRS zones, Miami was in the top 5 circuits for overtaking.

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