Complete Season 2014

*F1 Season 2014 – Volume 2*

*by Dominique Madier*

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# TABLE OF CONTENTS

1. **INTRODUCTION**

2. **ROUND 01/19 – AUSTRALIA**

3. **ROUND 02/19 – MALAYSIA**

The F1-Forecast Technical Files
http://www.f1-forecast.com
## Table of Contents

### 3.4  RED BULL RB10 – NEW REAR WING  
### 3.5  McLAREN MP4-29 - DOUBLE FLOOR / SIDEPOD DUCT  
### 3.6  McLAREN MP4-29 – NEW NOSE  
### 3.7  LOTUS E22 – NEW COOLING CONCEPT  
### 3.8  WILLIAMS FW36 - ENGINE COVER OUTLET  
### 3.9  SAUBER IS OVERWEIGHT  
### 3.10  TORO ROSSO STR9 - REAR WING SUPPORT PYLON (Y-LON)  
### 3.11  WHY F1 2014 IS LOUDER THAN YOU THINK  
### 3.12  TECHNICAL IMAGE GALLERY

### 4.  ROUND 03/19 – BAHRAIN  
#### 4.1  2014 VERSUS 2013 IN BAHRAIN  
#### 4.2  THE PROBLEM OF FUEL FLOW, IS THERE ONE?  
#### 4.3  MERCEDES W05 – SHORTEN NOSE  
#### 4.4  MERCEDES REVEALS TRUE SPACE IN BAHRAIN  
#### 4.5  RED BULL RB10 – FRONT WING  
#### 4.6  RED BULL RB10 – REAR DIFFUSER VORTEX GENERATORS  
#### 4.7  McLAREN MP4-29 – FRONT WING  
#### 4.8  McLAREN MP4-29 – REVISED NOSE / FRONT WING  
#### 4.9  LOTUS E22 – BRAKE DUCTS EXTRA USE  
#### 4.10  WILLIAMS FW36 - CENTRAL COOLING FUNNEL  
#### 4.11  LOTUS E22 - UNDER NOSE 'SNOWPLOUGH'  
#### 4.12  TORO ROSSO STR9 - NEW NOSE  
#### 4.13  WORKING AROUND THE BAN ON THE STARTER MOTOR HOLE  
#### 4.14  DID MERCEDES TAKE A CLOSE LOOK AT THE RB10?  
#### 4.15  TECHNICAL IMAGE GALLERY

### 5.  ROUND 04/19 – CHINA  
#### 5.1  CHINESE GP PRESS CONFERENCE – POWER UNIT MANUFACTURERS  
#### 5.2  FERRARI F14T - BLOWN WHEEL HUBS  
#### 5.3  FERRARI F14T – BLOWN FRONT AXLE  
#### 5.4  MERCEDES W05 - NEW NOSE  
#### 5.5  MERCEDES DEBUTS NEW HIGHER NOSE  
#### 5.6  MERCEDES W05 – SHORTENS NOSE  
#### 5.7  LOTUS E22 DIFFUSER VORTEX GENERATOR  
#### 5.8  LOTUS E22 – SHARK FIN ENGINE COVER  
#### 5.9  WILLIAMS FW36 - FRONT AND REAR WING EVALUATION  
#### 5.10  WILLIAMS FW36 - SIDEPOD SHOULDER VENTS  
#### 5.11  WILLIAMS FW36 – SHARK FIN ENGINE COVER  
#### 5.12  RED BULL RB10 – BRAKE DUCTS  
#### 5.13  RED BULL RB10 – TYRE SQUIRT SLOTS
| 5.14 | McLAREN MP4-29 – FRONT WING | 257 |
| 5.15 | FORCE INDIA VJM07 – NEW REAR WING | 258 |
| 5.16 | FORCE INDIA VJM07 - SIDEPOD, AIRFLOW CONDITIONER AND FRONT OF FLOOR MODIFICATIONS | 259 |
| 5.17 | FORCE INDIA VJM07 – REAR END DETAIL CHANGES (DIFFUSER & Y100 WINGLET) | 261 |
| 5.18 | FORCE INDIA VJM07 – REAR WING TWEAKS | 262 |
| 5.19 | TORO ROSSO VORTEX GENERATOR | 263 |
| 5.20 | THE 33.33 SECOND MISNOMER | 264 |

### 6. ROUND 05/19 – SPAIN

| 6.1 | THE SECRETS OF F1 FRONT WINGS | 266 |
| 6.2 | WHAT GAVE MERCEDES THE EDGE IN SPAIN? | 267 |
| 6.3 | FERRARI F14T - NEW REAR WING MOUNTING PACKAGE | 272 |
| 6.4 | FERRARI F14T – FRONT WING AMENDMENTS | 273 |
| 6.5 | FERRARI F14T – REAR WING SUPPORT PYLON, Y100 WINGLET & LARGER EXHAUST | 274 |
| 6.6 | FERRARI F14T – SINGLE WING PILLAR | 277 |
| 6.7 | FERRARI'S NEW SPANISH REAR WING ASSEMBLY | 278 |
| 6.8 | MERCEDES W05 – FRONT-WING VANE | 280 |
| 6.9 | WILLIAMS FW36 – WING MIRRORS | 281 |
| 6.10 | RED BULL RB10 – CHANGES SLOOR SLOT SHAPES | 282 |
| 6.11 | RED BULL RB10 - REAR FLOOR DUCT | 283 |
| 6.12 | RED BULL RB10 – NEW REAR WING ENDPLATES | 284 |
| 6.13 | SAUBER SHEDS WEIGHT WITH MAJOR CAR UPGRADE | 286 |
| 6.14 | SAUBER C33 – NEW FRONT WING | 288 |
| 6.15 | SAUBER C33 – NEW TURNING VANES | 289 |
| 6.16 | SAUBER C33 – NEW SIDEPODS | 290 |
| 6.17 | LOTUS E22 – NEW FRONT WING (UN-RACED) | 293 |
| 6.18 | LOTUS E22 – SIDEPOD BULGE | 294 |
| 6.19 | LOTUS E22 – Y100 WINGLET / MONKEY SEAT | 295 |
| 6.20 | McLAREN MP4-29 – BRAKE DUCT CHANGES | 296 |
| 6.21 | McLAREN BRINGS NEW DIFFUSER TO SPAIN | 298 |
| 6.22 | MARUSSIA MR03 – NEW NOSE | 300 |
| 6.23 | THE DECIBEL DEBACLE | 302 |
| 6.24 | MERCEDES W05 – Y100 WINGLET / MONKEY SEAT – POST BARCELONA GP TEST | 306 |
| 6.25 | TECHNICAL IMAGE GALLERY | 308 |

### 7. ROUND 06/19 – MONACO

| 7.1 | MONACO MONKEY (SEAT) BUSINESS | 372 |
| 7.2 | VIDEO - ANATOMY OF THE 2014 POWER UNIT | 381 |
| 7.3 | MERCEDES W05- NEW FRONT-WING ENDPLATE | 382 |
| 7.4 | MERCEDES W05- 'MONKEY SEAT' | 383 |
| 7.5 | MERCEDES W05 – NEW FRONT WING ENDPLATES | 384 |
## Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerodynamic &amp; Mechanical Updates 2014 – Volume 2</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Table of Contents</strong></td>
<td></td>
</tr>
<tr>
<td>7.6 <strong>MERCEDES &amp; RED BULL LOOK TO MONKEY SEATS</strong></td>
<td>385</td>
</tr>
<tr>
<td>7.7 <strong>RED BULL RB10 - 'MONKEY SEAT'</strong></td>
<td>386</td>
</tr>
<tr>
<td>7.8 <strong>RED BULL RB10 - NEW TURNING VANES, CAMERA MOUNTING</strong></td>
<td>387</td>
</tr>
<tr>
<td>7.9 <strong>LOTUS E22 – REAR WING ENDPLATE LEADING EDGE TYRE WAKE SLOTS</strong></td>
<td>388</td>
</tr>
<tr>
<td>7.10 <strong>LOTUS E22 - FRONT WING</strong></td>
<td>389</td>
</tr>
<tr>
<td>7.11 <strong>FERRARI F14T - COOLING CHANGES</strong></td>
<td>390</td>
</tr>
<tr>
<td>7.12 <strong>RED BULL RB10 - COOLING FUNNEL CHANGE</strong></td>
<td>392</td>
</tr>
<tr>
<td>7.13 <strong>INSIDE THE MIND OF F1’S BATTERIES AND ELECTRONICS</strong></td>
<td>394</td>
</tr>
<tr>
<td>7.14 <strong>TECHNICAL IMAGE GALLERY</strong></td>
<td>396</td>
</tr>
<tr>
<td>**8. <strong>ROUND 07/19 – CANADA</strong></td>
<td>427</td>
</tr>
<tr>
<td>8.1 <strong>VIDEO - BRAKE-BY-WIRE EXPLAINED</strong></td>
<td>427</td>
</tr>
<tr>
<td>8.2 <strong>VIDEO – FERRARI F1 ENGINE 2014 OVERVIEW</strong></td>
<td>428</td>
</tr>
<tr>
<td>8.3 <strong>VIDEO – WHY MERCEDES STRUCK TROUBLE IN CANADA</strong></td>
<td>429</td>
</tr>
<tr>
<td>8.4 <strong>VIDEO – F1 AERO UPDATE WITH CRAIG SCARBOROUGH</strong></td>
<td>430</td>
</tr>
<tr>
<td>8.5 <strong>SECRET OF F1’S STOPPING POWER</strong></td>
<td>431</td>
</tr>
<tr>
<td>8.6 <strong>FERRARI F14T - MONTREAL ENGINE COVER</strong></td>
<td>432</td>
</tr>
<tr>
<td>8.7 <strong>FERRARI F14T - TRIAL REVISED BODYWORK</strong></td>
<td>433</td>
</tr>
<tr>
<td>8.8 <strong>FERRARI F14T – LOW DOWNFORCE ENGINE COVER</strong></td>
<td>435</td>
</tr>
<tr>
<td>8.9 <strong>WILLIAMS FW36 - MONTREAL BRAKES</strong></td>
<td>436</td>
</tr>
<tr>
<td>8.10 ** McLAREN MP4-29 - MODIFIED REAR SUSPENSION BLOCKERS**</td>
<td>437</td>
</tr>
<tr>
<td>8.11 <strong>MERCEDES W05 - SUSPENSION UPDATES</strong></td>
<td>438</td>
</tr>
<tr>
<td>8.12 <strong>MERCEDES ERS ISSUES</strong></td>
<td>439</td>
</tr>
<tr>
<td>8.13 <strong>CATERHAM CT05 - LOUVRE-LESS REAR WING ENDPLATES</strong></td>
<td>442</td>
</tr>
<tr>
<td>8.14 <strong>MCLAREN MP4-29 - NO UPPER WISHBONE WINGS</strong></td>
<td>443</td>
</tr>
<tr>
<td>8.15 <strong>LOTUS E22 - REAR WING</strong></td>
<td>445</td>
</tr>
<tr>
<td>8.16 <strong>SAUBER C33 - NEW REAR WING</strong></td>
<td>446</td>
</tr>
<tr>
<td>8.17 <strong>RED BULL RB10 – LOW-DRAG REAR WING TWEAK</strong></td>
<td>448</td>
</tr>
<tr>
<td>8.18 <strong>MERCEDES W05 – FRONT-END REVISIONS</strong></td>
<td>449</td>
</tr>
<tr>
<td>8.19 <strong>TECHNICAL IMAGE GALLERY</strong></td>
<td>450</td>
</tr>
<tr>
<td>**9. <strong>ROUND 08/19 – AUSTRIA</strong></td>
<td>507</td>
</tr>
<tr>
<td>9.1 <strong>ANALYSIS: WHAT HAPPENED WITH RENAULT IN AUSTRIA?</strong></td>
<td>507</td>
</tr>
<tr>
<td>9.2 <strong>WILLIAMS FW36 - TRICK INTERCOOLER PACKAGING</strong></td>
<td>510</td>
</tr>
<tr>
<td>9.3 <strong>F1’S NEWEST FORM OF ENERGY RECOVERY</strong></td>
<td>511</td>
</tr>
<tr>
<td>9.4 <strong>MERCEDES W05 - HARNESING MERC’S HORSES</strong></td>
<td>513</td>
</tr>
<tr>
<td>9.5 <strong>FERRARI F14T - ENGINE COVER COOLING</strong></td>
<td>518</td>
</tr>
<tr>
<td>9.6 <strong>FERRARI F14T - SIDEPOD AND REAR WING AMENDMENTS</strong></td>
<td>519</td>
</tr>
<tr>
<td>9.7 <strong>FERRARI F14T - COOLING</strong></td>
<td>522</td>
</tr>
<tr>
<td>9.8 <strong>MCLAREN INTRODUCES SHAPELY NEW FRONT WING</strong></td>
<td>523</td>
</tr>
<tr>
<td>9.9 <strong>MCLAREN MP4-29 - EXPOSED REAR BRAKE DISCS</strong></td>
<td>525</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>9.10</td>
<td>MCLAREN MP4-29 - TRIAL NEW TURNING VANES</td>
</tr>
<tr>
<td>9.11</td>
<td>MCLAREN MP4-29 - NEW FRONT WING</td>
</tr>
<tr>
<td>9.12</td>
<td>MCLAREN MP4-29 - FRONT WING UPGRADE</td>
</tr>
<tr>
<td>9.13</td>
<td>MCLAREN MP4-29 - REAR END CHANGES</td>
</tr>
<tr>
<td>9.14</td>
<td>MCLAREN BACKTRACKS ON SUSPENSION BLOCKERS</td>
</tr>
<tr>
<td>9.15</td>
<td>NEW SIDEPODS JUST THE BEGINNING FOR TORO ROSSO</td>
</tr>
<tr>
<td>9.16</td>
<td>TORO ROSSO - NEW FRONT WING</td>
</tr>
<tr>
<td>9.17</td>
<td>TORO ROSSO STR9 - NEW FRONT WING</td>
</tr>
<tr>
<td>9.18</td>
<td>TORO ROSSO STR9 - FRONT WING ALTERATIONS</td>
</tr>
<tr>
<td>9.19</td>
<td>TORO ROSSO STR9 - SIDEPOD CHANGES</td>
</tr>
<tr>
<td>9.20</td>
<td>FORCE INDIA VJM07 - TWEAKED FRONT WING DESIGN</td>
</tr>
<tr>
<td>9.21</td>
<td>FORCE INDIA VJM07 - SINGLE REAR WING SUPPORT PYLON</td>
</tr>
<tr>
<td>9.22</td>
<td>FORCE INDIA VJM07 - NEW FRONT WING MOUNTING / NOSE</td>
</tr>
<tr>
<td>9.23</td>
<td>FORCE INDIA VJM07 - NEW FRONT WING (ENDPLATE)</td>
</tr>
<tr>
<td>9.24</td>
<td>FORCE INDIA VJM07 - FRONT BRAKE DUCT FIN</td>
</tr>
<tr>
<td>9.25</td>
<td>FORCE INDIA VJM07 – FRONT-WING PILLARS MOVED</td>
</tr>
<tr>
<td>9.26</td>
<td>FORCE INDIA VJM07 - NEW NOSE</td>
</tr>
<tr>
<td>9.27</td>
<td>FORCE INDIA VJM07 - TURNING VANES</td>
</tr>
<tr>
<td>9.28</td>
<td>FORCE INDIA VJM07 - SIDEPOD AND COOLING CHANGES</td>
</tr>
<tr>
<td>9.29</td>
<td>RED BULL RB10 - REAR END CHANGES</td>
</tr>
<tr>
<td>9.30</td>
<td>TECHNICAL IMAGE GALLERY</td>
</tr>
</tbody>
</table>

10.      ROUND 09/19 – GREAT BRITAIN                                      579

10.1    | VIDEO – TECH UPDATE 2014 WITH CRAIG SCARBOROUGH                        | 579  |
10.2    | MERCEDES W05 - NEW TURNING VANES                                      | 580  |
10.3    | MERCEDES W05 - SIDEPOD AIRFLOW CONDITIONERS                            | 581  |
10.4    | MCLAREN MP4-29 - FLOOR MODIFICATIONS                                  | 583  |
10.5    | FERRARI F14T - FRONT BRAKE COOLING, PART ONE                          | 584  |
10.6    | FERRARI F14T - FRONT BRAKE COOLING, PART TWO                          | 585  |
10.7    | FERRARI F14T – POWER UNIT INSTALLATION                                | 586  |
10.8    | FERRARI F14T - FRONT BRAKE DUCTS                                       | 587  |
10.9    | RED BULL RB10 - FRONT WING AMENDMENTS                                  | 588  |
10.10   | RED BULL RB10 – ENDPLATE VANE GETS CURVIER                            | 590  |
10.11   | RED BULL RB10 - REAR WING MOUNTING PYLON                               | 591  |
10.12   | MCLAREN MP4-29 – FLOOR SLOTS                                           | 592  |
10.13   | MCLAREN MP4-29 - DOG-LEGGED 'TYRE SQUIRT' SLOT                        | 593  |
10.14   | FORCE INDIA VJM07 – REAR WING SUPPORT                                 | 595  |
10.15   | TECHNICAL IMAGE GALLERY                                                | 596  |

11.      ROUND 10/19 – GERMANY                                           669

11.1    | VIDEO – TECH OVERVIEW WITH CRAIG SCARBOROUGH                          | 669  |
## Table of Contents

11.2 MCLAREN MP4-29 – SERRATED REAR WING 670  
11.3 MCLAREN MP4-29 – REAR WING SETUP 671  
11.4 MCLAREN MP4-29 - NEW TUBERCLES INSPIRED REAR WING 672  
11.5 WILLIAMS FW36 - LOUVRED SHARK FIN ENGINE COVER 676  
11.6 WILLIAMS FW36 - REVIVED SHARK GILLS FOR COOLING 678  
11.7 LOTUS E22 - ADDITIONAL COOLING 679  
11.8 LOTUS E22 - ENDPLATE CUT-OUT 680  
11.9 LOTUS E22 - FRONT WING 681  
11.10 FERRARI F14T - REAR END CHANGES 685  
11.11 FORCE INDIA VJM07 - IMPROVED COOLING SOLUTION 687  
11.12 FORCE INDIA VJM07 – CAR COOLING 688  
11.13 FORCE INDIA VJM07 + SNORKEL-LESS ENGINE COVER 689  
11.14 MARUSSIA MR03 - HEAT-CONTAINING EXHAUST COVER 691  
11.15 RED BULL RB10 - DIFFERING CONFIGURATIONS 692  

### 12. ROUND 11/19 – HUNGARY 694  
12.1 FERRARI F14T - OIL TANK REPOSITIONING 694  
12.2 STEERING: ONE OF THE LAST BASTIONS OF MECHANICAL F1 696  
12.3 RENAULT CONSIDERS SPLIT MERC-STYLE TURBO FOR 2015 698  
12.4 MERCEDES W05 – TUNED BRAKE COOLING 699  
12.6 LOTUS E22 - NEW FRONT WING ENDPLATE 700  
12.7 WILLIAMS FW36 – AIRBOX WINGS AID AIRFLOW 701  
12.8 WILLIAMS FW36 - ADDITIONAL WING ON ROLL HOOP 702  
12.9 WILLIAMS FW36 - ROLL HOOP WINGLET 703  
12.10 WILLIAMS FW36 - COOLING OPTIONS 705  
12.11 FORCE INDIA CONTINUES TO SWITCH BETWEEN ENGINE COVERS 706  
12.12 TECHNICAL IMAGE GALLERY 708  

### 13. ROUND 12/19 – BELGIUM 728  
13.1 OVERCOMING THE PROBLEMS OF F1 WEATHER FORECASTING 728  
13.2 FERRARI F14T - REAR-MOUNTED MGU-K LAYOUT 729  
13.3 FERRARI F14T – FRONT WING(s) 730  
13.4 FERRARI F14T – REAR WING 733  
13.5 RED BULL RB10 - LIGHTWEIGHT BRAKE ASSEMBLY 736  
13.6 RED BULL RB10 – REAR WING 737  
13.7 MERCEDES W05 - NEW LOW-Drag REAR WING 742  
13.8 MERCEDES W05 - WING REDUCES DRAG 743  
13.9 MERCEDES W05 - LIGHTWEIGHT NOSE 744  
13.10 MERCEDES W05 – REAR WING 745  
13.11 MERCEDES W05 – RESTRUCTURED NOSE, TURNING VANES & BRAKES DUCT FIN 748  
13.12 MERCEDES KEEP ADVANTAGE WITH AERO UPDATES 752
13.13 **McLaren MP4-29 - Low-Downforce Rear Wing**
13.14 **McLaren MP4-29 – Diffuser**
13.15 **McLaren MP4-29 – Rear Wing**
13.16 **McLaren MP4-29 – Rear End Vortex Control**
13.17 **Ferrari Powered Teams Exhaust Covering**
13.18 **Force India VJM07 - New Y100 Winglet / Monkey Seat**
13.19 **Caterham CT05 – New Nose**
13.20 **Caterham CT05 – Engine Cover**
13.21 **Caterham Debuts New Nose Cone**
13.22 **Caterham CT05 – Rear Wing Endplate Stakes**
13.23 **Lotus E22 – Rear Wing**
13.24 **Lotus E22 – Winglet Helps Manage Airflow**
13.25 **Lotus E22 – Asymmetric Cooling Outlet**

**14. ROUND 13/19 – ITALY**

14.1 **Red Bull RB10 Front Wing**
14.2 **Red Bull RB10 Rear Wing**
14.3 **Red Bull RB10 – Lose Their Beam Wing Slice**
14.4 **Red Bull RB10 – Cascade Less Front Wing**
14.5 **Video – Red Bull-Lotus-Renault Tech Overview with Craig Scarborough**
14.6 **Video – Ferrari Tech Overview with Craig Scarborough**
14.7 **Ferrari F14T Front Wing**
14.8 **Ferrari F14T – Cascade Less Front Wing**
14.9 **Ferrari F14T – Rear Wing**
14.10 **Ferrari F14T - Diffuser**
14.11 **Ferrari Wing Wins Beauty Contest**
14.12 **McLaren MP4-29 - Rear Wing**
14.13 **Williams Low-Drag Rear Wing for Monza**
14.14 **Williams FW36 – Front Wing**
14.15 **Video – Mercedes Tech Overview with Craig Scarborough**
14.16 **Mercedes W05 – Rear Wing**
14.17 **Mercedes W05 – Tyre Squirt Slot**
14.18 **Mercedes W05 – Wing Mirror Mounts & Cockpit Fin**
14.19 **Mercedes Tweaks Wings and Floors**
14.20 **Toro Rosso STR9 - Front Wing**
14.21 **Toro Rosso STR9**
14.22 **Force India VJM07 – Shorter Chords**
14.23 **Sauber C33 – Rear Wing**
14.24 **Caterham CT05 – Front Wing**
14.25 **Williams FW36 – Rear Wing**
14.26 **Lotus E22 - Trim Tiny Rear Wing for Top Speed**
# Table of Contents

14.27 LOTUS E22 – REAR END CHANGES 824
14.28 FEEDING FUEL TO THE HEART OF THE MATTER 826

15. ROUND 14/19 – SINGAPORE 828
15.1 MERCEDES W05 - Y100 WINGLET 828
15.2 MERCEDES W05 – GEAR RATIO CHANGE 830
15.3 RED BULL RB10 - REVISED NOSE DESIGN 832
15.4 McLAREN MP4-29 - REAR DIFFUSER UPDATE 833
15.5 McLAREN MP4-29 - Y100 LADDER WINGLET CHANGE 834
15.6 WILLIAMS FW36 – FRONT & REAR BRAKE DUCTS 836
15.7 SAUBER C33 - REVISED FRONT WING 840
15.8 SAUBER C33 – FRONT WING 841
15.9 SAUBER C33 - SIDEPODS 842
15.10 SAUBER C33 – TIDY ENGINE COVER 844
15.11 FORCE INDIA VJM07 – FRONT WING 845
15.12 FORCE INDIA VJM07 – DIFFUSER & REAR BREAK DUCT WINGLET 847
15.13 STEERING WHEEL DATA DISPLAYS - LARGE VERSUS SMALL 850
15.14 RED BULL RB10 – CHANGERS FOR SINGAPORE 851
15.15 HONDA ARE BACK 855
15.16 (WIND) TUNNEL VISION 857
15.17 TECHNICAL IMAGE GALLERY 860

16. ROUND 15/19 – JAPAN 896
16.1 VIDEO – F1 TECH OVERVIEW WITH CRAIG SCARBOROUGH 896
16.2 MERCEDES W05 - SUZUKA AERO UPGRADES 897
16.3 MERCEDES W05 – DETACHED FLOOR SCROLL 898
16.4 MERCEDES W05 – FRONT WING 900
16.5 MERCEDES W05 – COCKPIT COOLING SLOT 901
16.6 MERCEDES W05 - DIFFUSER 903
16.7 FERRARI F14T – FRONT WING 904
16.8 RED BULL RB10 - POWER UNIT CONFIGURATION 905
16.9 WILLIAMS FW36 - REVISED ENGINE COVER 906
16.10 WILLIAMS FW36 – ENGINE COVER 907
16.11 TORO ROSSO STR9 – NEW NOSE 909
16.12 TORO ROSSO STR9 - ADDS S-DUCT IN NEW NOSE 911
16.13 TORO ROSSO STR9 - Y100 WINGLETS 913
16.14 TORO ROSSO STR9 - BARGEBOARDS 917
16.15 CATERHAM CT05 – FRONT WING 919
16.16 TECHNICAL IMAGE GALLERY 921

17. ROUND 16/19 – RUSSIA 956
Aerodynamic & Mechanical Updates 2014 – Volume 2

Table of Contents

17.1 VIDEO – SCARBS ON SOTCHI – F1 TECH UPDATE
17.2 VIDEO – F1 CLOSED COCKPIT: WHAT THEY’LL LOOK LIKE
17.3 VIDEO – MERCEDES F1 GEARBOX SECRETS REVEALED – SCARBS UPDATE
17.4 MERCEDES W05 – CLEVER TWO PARTS GEARBOX EXPLAINED
17.5 MERCEDES W05 - NEW DIFFUSER
17.6 MERCEDES W05 – REAR WING & Y100 WINGLET
17.7 McLAREN MP4-29 - EXPERIMENTAL 2015 FRONT WING
17.8 McLAREN MP4-29 – FRONT WING
17.9 RED BULL RB10 - FRONT WING UPDATES
17.10 TORO ROSSO STR9 - BARGEBOARDS
17.11 TECHNICAL IMAGE GALLERY

18. ROUND 17/19 – USA

18.1 VIDEO – MERCEDES TECH OVERVIEW WITH CRAIG SCARBOROUGH
18.2 FORCE INDIA RUNS BIGGER DISPLAY
18.3 FERRARI F14T - 2015-FOCUSED REAR WING
18.4 FERRARI F14T – REAR WING ENDPLATE GRADIENT SLOTS
18.5 RED BULL RB10 – NEW UPPER Y100 WINGLET ‘MONKEY SEAT’
18.6 WILLIAMS FW36 - REVISED BRAKE DUCT FAIRING
18.7 McLAREN MP4-29 - REVISED NOSE
18.8 McLAREN MP4-29 – ‘PELICAN UNDER BELLY’ NOSE
18.9 LOTUS E22 - DEBUTS 2015 NOSE CONCEPT
18.10 LOTUS E22 - TRIAL 2015 NOSE CONFIGURATION
18.11 LOTUS E22 – TEST NOSE

19. ROUND 18/19 – BRAZIL

19.1 RED BULL RB10 - REAR WING UPDATES
19.2 FERRARI F14T - ASYMMETRIC REAR SUSPENSION
19.3 FERRARI F14T - REAR BRAKE CONFIGURATION
19.4 FERRARI TESTS NEW SUSPENSION
19.5 MERCEDES W05 - BRAKE OVERVIEW
19.6 McLAREN MP4-29 – FRONT WING & TITANIUM SKID TEST
19.7 TECHNICAL IMAGE GALLERY

20. ROUND 19/19 – ABU DHABI

20.1 VIDEO – ABU DHABI TECH OVERVIEW WITH CRAIG SCARBOROUGH
20.2 VIDEO – RED BULL FRONT WING ILLEGALITIES EXPLAINED BY CRAIG SCARBOROUGH
20.3 MERCEDES W05 – NEW TURNING VANES
20.4 McLAREN MP4-29 – NEW FRONT WING
20.5 McLAREN MP4-29 – TURNING VANES

The F1-Forecast Technical Files
http://www.f1-forecast.com
1. **INTRODUCTION**

The purpose of this new report of the series « The Technical Files of F1-Forecast » is to present some aerodynamic and mechanical updates of the 2014 F1 cars.

The Volume 1 presented the New 2014 F1 cars and the updates tested during the three winter test sessions in Spain.

This Volume 2 presents the technical updates seen during each week-end of race.

The updates are presented with pictures, drawings, videos and comments coming from:

- *SomersF1 blog* by Matt Somerfield: [http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)
- *Steven De Groote* from *F1 Technical.net* web site: [http://www.f1technical.net/](http://www.f1technical.net/)
- *Craig Scarborough* from [http://www.autosport.com/f1](http://www.autosport.com/f1) & *The Racer’s Edge*
- *Scarbsf1’s Blog* by Craig Scarborough: [http://scarbsf1.wordpress.com/](http://scarbsf1.wordpress.com/)
- *The Racer’s Edge* by Peter Windsor & Craig Scarborough: [https://www.youtube.com/user/peterwindsor](https://www.youtube.com/user/peterwindsor)
- *Formula 1 Tech and Art’s Blog* by Michalis K [Bar555]: [http://formula1techandart.wordpress.com/](http://formula1techandart.wordpress.com/)

F1-Forecast.com wishes you a good reading.

*Dominique Madier*
Webmaster *F1-Forecast.com*
Montreal – Canada – November 2014
2. **ROUND 01/19 – AUSTRALIA**

2.1 **FORMULA ONE’S 2014 POWER UNITS EXPLAINED**

[SomersF1 blog by Matt Somerfield:](http://somersf1.blogspot.co.uk)
2.2 **SOUNDING off.. AREN'T WE HERE FOR THE RACING?**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Our senses make us subjective creatures and so it's often said, we eat with our eyes. Formula One's move into a new technologically advanced era has once again bought up the question of sensory appeal. This weekend I've seen key figures like Martin Brundle and Bernie Ecclestone deriding F1's soundtrack and unfortunately as they're in a position of influence this can further sway opinion.

Do you remember the V12's of yesteryear? We're you disappointed when the switch was made to V10's? How about when the V10's were swapped out for V8's? Or maybe when the V8's rev limits were curtailed to 18,000rpm?

These are all signs of progression and at the time we all yearned for the sounds of their predecessors but as time went by we learn to accept and then love the new auditory pleasures at hand.

The same can be said for aesthetics, another battle ground over the seasons where teams have chosen what suits their aerodynamic needs over the way the cars look (step noses and now finger noses) but as time goes by we adapt and learn to accept that which is better.

The condemnation of the new Power units sound is loud and clear but frankly given the regulations there is nowhere to go.

In order to increase the sound of the new V6 Turbo units I see only 2 solutions, a mandated change to the exhaust system, inevitably leading to arguments amongst the teams, power unit manufacturers and FIA as each grapple with a regulation change that would have technical ramifications. (Performance could be won or lost and be detrimental to the health of the Power units due to limited testing.

Or something that's caused a backlash amongst car owners over the last few years who've felt cheated by the installation of sound enhancing devices, bridging the gap as the vehicles sounds theirselves are attenuated. The Volkswagen Golf GTi is perhaps the most well known/documented of these with owners even going as far as removing the devices.

From a personal perspective I have no problem with the new F1 soundtrack. Yes they're quieter and you won't feel like your chest cavity is about to erupt as the cars thunder past. However if you take the time to listen you can discern much more, as the driver stamps on the throttle we hear the MGU-H and K whining, producing power that then assists the Turbo and we get a rush of boost. Heading into the braking zone, you can hear the K harvesting energy whilst the H
keeps the turbo spooled and then almost instantaneously the boost is at full song as the driver hurtles on his way.

This isn't the only thing though, as the diminished engine sounds also lead us to a juncture where you can hear the tyres squeal under load through the corners as they struggle to both stop the car, turn in and then deal with the increased torque of the new Power units. Furthermore you can even hear the front edge of the plank hitting the floor, as the car pitches forward under braking.

Lastly have you ever heard the furore from the crowd as the driver rounds the last corner during qualifying? Certainly nothing like we heard in Melbourne. The crowds elation was clear to hear and I think we all rode that emotional roller coaster with the crowd.

I for one don't have a problem with the new Power units but having been through several downsizings in the past I can understand why others are having problems assimilating. As time passes by though I'm sure you'll all come to live with the sound. Besides this is just the start! Remember how much exhausts were exploited in the past to extract aero performance, changing the sound characteristics as they went. (Especially the gunfire sounds of the Off Throttle exhaust blown diffusers of 2010)
2.3 **WE EXPLAIN WHY RICCIARDO WAS DISQUALIFIED AS FLOWGATE BECOMES F1’S LATEST SAGA**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The 2014 edition of Formula 1 will probably best be remembered as the season that introduced one of the largest regulation shake ups in the history of the sport. This has came to bite Red Bull and Daniel Ricciardo particularly hard in Melbourne and with it ‘Flowgate’ becomes the sport’s latest high profile controversy.

Having pushed aside the doubters who made the most noise during the pre-season, Daniel proceeded to put his RB10 between the two pace setting Silver Arrows of Lewis Hamilton and Nico Rosberg in Qualifying. Although he wasn’t able to chase and challenge Rosberg during the race he did hold station and the advances of rookie Kevin Magnussen from behind were also thwarted.

That being said the body language of Red Bull was that of a team who had been caught on the back foot, still adjusting to the new era after four glorious, dominant years.

On the day in Melbourne Daniel’s elation was short lived with his podium finish unceremoniously stripped from his grasp hours later, as the stewards highlighted discrepancies in his fuel usage throughout the race. The new rules require a maximum of 100 kg/h of fuel to be delivered during the race, which Daniel’s RB10 had been exceeding.

As always with these matters however the team and the FIA were at loggerheads, with Red Bull complaining that the sensor that gives the FIA this information was faulty.

The FIA’s release however reveals their transparency in the matter and reveals Red Bull’s deceit, during Free Practice 1 the sensor gave eronious readings in their fourth run when compared with the previous three, although the same readings were present from run four throughout Free Practice 2.

With the agreement of the FIA the sensor was changed for FP3 and Qualifying but was not producing readouts deemed satisfactory by the team or the FIA. The FIA therefore asked for the sensor to be changed, with the original sensor being restored to use.

This sensor provided the same readouts as it did during run 4 of FP1 and all of FP2, this is an important factor as it’s correlation gives a definitive baseline reading. Once the sensor had been replaced post Qualifying the technical representative instructed the team to apply an offset to their fuel flow such that it would be legal (something done up and down the grid).
The team stated that based on the difference that they observed between the two readings in FP1, they considered the fuel flow sensor to be unreliable. Therefore, for the start of the race they chose to use their internal fuel flow model, rather than the values provided by the sensor, with the FIA’s prescribed offset.

The FIA’s technical representative noted during the race that the fuel flow was too high and contacted the team, giving them the opportunity to follow his previous instructions of creating an offset from the fuel flow sensor’s readings. Having been given the opportunity during the race to comply, the team chose not to make any corrections.

Red Bull have clearly shown contempt for the rule makers in their actions and operated outside of the regulations. The inference to both articles:

5.1.4 Fuel mass flow must not exceed 100 kg/h.
5.1.5 Below 10,500 rpm the fuel mass flow must not exceed $Q \text{ (kg/h)} = 0.009 N \text{(rpm)} + 5.5$.

Means the team were not only exceeding the fuel flow limit toward the upper end of the scale but also below 10,500rpm. The upshot of this is an increase in performance – with more fuel being supplied, inevitably the ICE will produce more power.
The differential in terms of fuel flow from the baseline has not been revealed and so to infer how much of an advantage was gained by Red Bull would be impossible but suffice to say there was a performance advantage there.

The crux of Red Bull’s decision probably lies firmly in simulations that the team would have run back at Milton Keynes, with both their own fuel flow model and that of the FIA’s with the necessary offset.

These simulations would have given the team a clear indication as to the performance differential between both models and the likely upshot in performance.

In terms of the team making an appeal against the FIA’s decision, they have nothing to lose but the evidence at hand suggests that, unless a wide sweeping change is made to the way in which fuel flow is monitored Red Bull operated outside of both the Sporting and Technical regulations. (Analysis by Matthew Somerfield)
2.4 **FIA BACKS FUEL FLOW SENSOR MAKER IN AFTERMATH OF RED BULL DISQUALIFICATION**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Formula 1’s governing body is satisfied with the ultrasonic fuel flow meter, the accuracy of which was questioned by champions Red Bull after Daniel Ricciardo was disqualified from the season-opening Australian Grand Prix, the makers said.

Gill Sensors released the following statement: “Following the Australian Grand Prix last weekend, the FIA have provided Gill Sensors with positive feedback on the performance of the Fuel Flow Meter, confirming their confidence in the development and stating [that] the meters meet the FIA’s accuracy specification.”

“The meter development included an extensive testing programme, which involved liaising with many of the F1 teams for their valuable feedback on meter design and functionality. Meter calibration is handled by the FIA’s third party calibration company.”
“The meters utilise ultrasonic technology which was selected for its resilience in extreme operating conditions. The FIA chose Gill Sensors for this complex development because of Gill’s 29 years of proven experience in Ultrasonics.”

Meanwhile Red Bull have appealed against their Australian driver’s disqualification, arguing that the flow meter was inaccurate and unreliable, with the matter now set to be resolved by lawyers in an FIA court.

The first big technical controversy of the year is unlikely to be the only one as the sport grapples with complex regulations governing the new V6 turbo engines and energy recovery systems.

Ricciardo finished second at Albert Park but was disqualified more than five hours later after stewards ruled that his team had broken new regulations that limit the flow of fuel to the new V6 turbocharged engines.
The Melbourne Herald Sun headline on Monday branded it a “Grand Farce”.

The FIA said Ricciardo’s car “exceeded constantly” the rules limiting fuel flow to 100 kg per hour.

Allowing the fuel to flow faster than allowed in the regulations would give a team that did so a power advantage over others.

The FIA said on Sunday that Red Bull had been told during the race that telemetry readings showed the fuel flow on Ricciardo’s car was too high but the team had failed to correct the situation.

Red Bull Team Principal Christian Horner argued that inconsistencies with the meters had “been prevalent all weekend up and down the pitlane”.

The stewards ruled that “regardless of the team’s assertion that the sensor was fault, it is not within their discretion to run a different fuel flow measurement method without the permission of the FIA.”
Gill Sensors said that their meter, which uses an ultrasonic sensor, had been tested extensively by many of the teams, who had provided feedback on design and functionality. (Reuters) Subbed by AJN.
2.5 **WINGS OF CHANGE IN MELBOURNE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

With blown diffusers and the elimination of exhaust assisted aero, teams are pushing development to regain downforce in the new V6 turbo era, and with huge torque on tap downforce at low speeds is the Valhalla everyone is aiming for.

During the Australian Grand Prix weekend teams were testing front wing derivatives in this quest for more grip – tech guru Matthew Somerfield gives us the lowdown on what he saw in the Melbourne pitlane.

**Mercedes W05 – New Front Wing**

Having not only covered extensive mileage during the pre-season tests but also worked on several cooling configurations, Mercedes have arrived in Melbourne with the rest of the field looking at them as the team to beat. However as previous seasons have proven having the right power unit is not the only concern for a team and they will need to focus heavily on strategy and aerodynamic performance too.
The latter is something the team have clearly worked hard on for 2014 with the W05 featuring not only some exclusive ideas but the convergence of tried and tested solutions run by other teams in previous seasons. 

As part of the build up process the team have revealed a new front wing, left laid on the setup trestle the image provides a great way to analyse the new and old configurations back to back. The new front wing has very few major changes to the actual wing profiles themselves and points to these operating as the team intended. Instead the changes are focused on the major rule change introduced that affects the front wing.

The reduction in it’s width from 1800 mm to 1650 mm (150 mm or 75 mm either side). The largest of the ramifications of this change is the way in which the teams turn the airflow around and over the front tyre. This has a dramatic effect as it will also change the way in which the airflow works behind the tyre and re-engages with the floor.

This has led to a change in two area’s between the wings, the outer Endplate [1] that has followed a similar ethos leading all the way back to the championship winning BGP001. This features a full length section rather than the multiple split endplates used for numerous years, which will undoubtedly refocus the airflow.

Symbiotically, a change in both the large outer cascade [2] and the deletion of the smaller cascade [3] but installation of a vertical turning vane [4] will change the way in which the airflow moves outbound and how it interacts or impinges on the rest of the wing. 
(Note: Although this new front wing was tried in Melbourne the team decided not to use it for Qualifying or the race, this is not to say it does not do as it should, but that the team were assessing its performance for another race.)
Red Bull RB10 – New Front Wing

Red Bull Racing arrived in Melbourne on the back foot, problems during the pre-season tests curtailed the mileage covered by the team, scuppering their assessment of aerodynamic solutions.

The team therefore arrived in Australia with several new components, one of which is a new front wing.

The wing itself was not massively different to it’s predecessor (inset) but does feature much more curvature to the main plane as it meets with the endplate.

Furthermore, the components associated with controlling airflow around and over the tyre have some amendments. Changes in this area will improve the performance of not only the front wing but also the floor and sidepods which are affected by the tyre wake as it tries to make it’s way back into the flow structure.

The main outer cascade now features 3 tiers rather than 2 whilst a vertical strake is mounted centrally within. The strake also features a slot and so will perform more effectively in yaw, whilst the horizontal blade that was affixed to the older specification endplate is deleted.
McLaren MP4-29 – Revised Front Wing

Basking in the opportunity to run significant mileage during pre-season testing, McLaren were in good stead heading to Melbourne. Having made some significant errors with the ‘28’ the team are eager to show their worth with the new car.

The team arrived in Melbourne have a revised front wing that is further keyed at extracting performance given the change of width for 2014.

The team have deleted the smaller cascade element used during testing, whilst an additional vane has been added inbound of the endplate [1]. The purpose of this vane is to further control the flow of air around and over the front tyre with the 75mm loss (either side) meaning the teams need to change their approach a little this season.

This is important due to the way in which the tyre wake tries to impinge on the sidepod and floor downstream. (Analysis by Matthew Somerfield)
Despite the fact that Mercedes led pre-season testing, the team introduced a new aero package between the last Bahrain session and Melbourne. Highlighted in this drawing are the aero updates on the central section of the car (previous solutions inset), with modified turning vanes under the chassis (two arrows to the right), a totally new horizontal fin attached to a laser sensor to measure ride height (middle arrow), and modified vertical turning vanes beside the sidepods with a split section on top and a bridge connection (left arrow).
2.7 **MERCEDES W05 – UPGRADE TEST-SPEC WING**


**Mercedes upgrades test-spec wing**

Mercedes ran a new front wing in Australia (pictured above). The changes are focused on turning the airflow outside the front tyre. The main change concerns the outboard edge, which was previously two sections but is now a continuous surface and more powerful.

Making the outboard part of the front-wing endplate work more aggressively will have an impact inboard. A vertical vane (1) replaces the previous horizontal one (2), while a horizontal vane (3) has been removed. There is also a small detail change at the bottom of the endplate (6) as a consequence of the developments.
2.8 **MERCEDES W05 - ROLL HOOP / AIRBOX SNORKEL INLETS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

For a short period of time during their running on day 4 (inset), Mercedes continued their assault on ticking the boxes, dotting the I's and crossing the T's. This came in the form of yet another cooling option but one that the team have used on their previous cars. The snorkel inlet reside atop of the engine cover a little aft of the engine airbox and in most likelihood takes care of cooling an oil cooler that usually resides above the gearbox or the Turbo's turbine which sits on the rear of the Mercedes power unit (Mercedes have split their Turbo with the compressor sitting one end of the engines V and the turbine the other, with a connecting shaft and MGU-H running through the V.

In Melbourne a revised version of these (perhaps hurriedly on site 3D printed appendages for the last test) appeared on the W05 signaling their long term inclusion as part of the cooling package. The snorkel inlets are a little larger and although this will compromise rear wing performance a little it's better to be on the safe side of the thermal margins at this early stage.
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2.9 **MERCEDES DIFFUSER GETS HOLE SHOT**


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The Mercedes ran with a diffuser featuring a vertical starter hole in a vane, which attracted attention from other teams but is legal. The vertical splitters (1) compartmentalise the diffuser so any airflow separation does not spread across the whole width. One of these vanes is offset and has a vertical starter-hole slot. Usually, cars have an elliptical hole in the surface of the diffuser, but this interrupts the airflow so Mercedes has removed that negative. The starter hole can be offset, provided it leads into the layshaft that runs through the gearbox.

The outboard edge of the diffuser (2) has a large gurney flap. This is to make the low-pressure area behind the rear tyre work with the diffuser. The flap turns the airflow coming out of the diffuser edge so it connects to the low-pressure area. This pulls more air through the diffuser, accelerating the airflow under the flat floor and increasing downforce through ground effect.

The Mercedes features detail work between the front wing and sidepods designed to improve airflow to the rear of the car. The three lower arrows show how this is being achieved. The airflow comes off the front wing and is then squeezed between the tyres. These two vanes expand it back out and feed it to the leading edge of the sidepods. The aim is to get as much air at as high a velocity as possible around the tyres to the leading edge of the sidepods.

The upper arrow indicates a vane on top of the sidepod. The airflow coming off the front wing is at an angle of around 15 degrees and if that accelerates over the top of the sidepod, it creates lift. The airflow over the top and sides of the sidepod is already being accelerated by the Coke-bottle design. This vane is designed to prevent the airflow from the front wing making that worse.
2.10  **ENGINE PACKAGING COMPARISON**


**Toro Rosso-Renault**

1. The pipe size suggests this is the oil radiator, which is mounted higher than you would ideally want as it raises the centre of gravity.
2. This appears to be the water radiator, judging by the pipe size.
3. The intercooler, to keep the charge air temperature as low as possible. Some teams seem to have heat exchangers instead. The intercooler, although bulkier, is the best solution.
4. Accumulator for the water system. This keeps the water under pressure to prevent it boiling. The FIA mandates a pressure-release valve at 3.75 bar to prevent excessive pressures and temperatures being used.
5. The connection between the turbo and the intercooler.
6. The turbo wastegate. Whenever you go into overboost, you need a wastegate. The idea is that the electric motor on the turbo (MGU-H) should control the boost pressure and ensure the wastegate is used only in emergencies. One of Renault's problems seems to be using the wastegate and motor to control boost. The wastegate exit is re-connected to the exhaust outlet because the regulations require a single pipe.

**Williams-Mercedes**

1. The turbocharger. Notice that the wastegate isn't visible in this area while Toro Rosso's is. The turbo is low for centre of gravity reasons.
2. Judging by the size of the pipework this is the oil cooler.
3. Water cooler.
4. The intercooler is mounted relatively low. It's not clear how it connects to the turbo, but the pipe could run through various places, including the gearbox bellhousing.
2.11 **MERCEDES F1 W05 - INTERCOOLER ADVANTAGE**


Another 'secret weapon' that the all-conquering 2014 Mercedes appears to have is an intercooler inserted into the top area of the chassis, circled here in yellow. This intercooler cools the turbocharged airflow that is going into the engine. As illustrated by the blue arrows, airflow from underneath the car's main air intake is passed across the intercooler, reducing the internal air temperature. The cooler this airflow is the more horsepower the engine will generate. With so many different systems on the cars now requiring cooling, this is a real packaging benefit for Mercedes, and one which will be difficult for other teams to copy.
If we compare the component installations on Mercedes' and Renault's power units, it is easy to see how different their concepts are. One of the fundamental requirements of a turbocharged engine is to reduce the temperature of the charge air (the blue part of the turbo) - the cooler this charge air is, the more power the engine will produce. Unlike Renault, Mercedes have separated the hot side of the turbo (in red) from the cold side (in blue) and have the MGU-H mounted in the 'V' of the engine between the two parts of the turbo. This has two main advantages: firstly, the heat transfer between the two parts of the turbo is minimised, so less cooling is required to keep the charge air temperature down (or if the same cooling capacity is used, the charge air temperature will be lower, giving more power to the rear wheels). Secondly, having the MGU-H mounted between the two sides of the turbo could allow Mercedes to have either or both sides working through one-way clutches, making the complete unit more efficient. Basically the exhaust gases coming out of the engine on the hot side of the turbo only ever have to drive the cold side of the turbo and or the MGU-H, creating electrical power from this component and feeding it directly to the MGU-K. The MGU-H only ever has to drive the cold side of the turbo, increasing the charge air pressure, thus reducing turbo lag and increasing power. The potential advantages of the Mercedes concept could be significant over the course of the season, especially as retro fitting a similar solution will be very difficult for the other power unit manufacturers.
If we compare the component installations on Renault's and Mercedes' power units, it is easy to see how different their concepts are. One of the fundamental requirements of a turbocharged engine is to reduce the temperature of the charge air (the blue part of the turbo) - the cooler this charge air is, the more power the engine will produce. Unlike Mercedes, Renault have the hot side of the turbo (shown in red) bolted directly to the cold side (in blue). There is heat insulation between them, but there will inevitably still be a lot of heat transfer between the two parts, meaning that a larger intercooler and more airflow will have to be used to reduce the charge air temperature. Mounted to the cold side of the turbo is the MGU-H, which will drive or be driven by the turbo through a central shaft. With this packaging both turbo elements will be driven simultaneously (whereas Mercedes' solution offers the possibility of driving the two elements independently).
2.14 **RED BULL ROW COULD OPEN A CAN OF WORMS FOR F1**


Red Bull’s decision to appeal Daniel Ricciardo’s disqualification from the Australian Grand Prix for fuel-flow irregularities has triggered a test case that could define the success of Formula 1’s new fuel-efficiency regulations.

The Milton Keynes-based team has challenged Ricciardo’s exclusion from second place in Melbourne because it is convinced it did not break the rules by using more than 100kg of fuel per hour. This is despite the FIA’s own calibrated fuel-flow sensor data indicating that Ricciardo ‘consistently’ exceeded the maximum rate during the race.

Red Bull believes that the governing body’s own readings cannot be trusted.

Rival teams are keeping a close eye on the case, because if Red Bull succeeds it could open the floodgates for everyone to ignore the FIA limits. One high-level source said that if teams are allowed the freedom to ignore the FIA’s fuel-flow sensor readings and opt for their own, then it will make the 2014 fuel-efficiency regulations almost impossible to police.

It means that there would be no surefire way of guaranteeing teams were complying with the 100kg and 100 kg/h limits, which are central to the new formula.

**THE BACKGROUND**

F1 has introduced new fuel-efficiency regulations this year, whereby teams are limited to 100kg of petrol from lights to chequered flag. Additionally, teams cannot use the fuel at a rate greater than 100kg per hour. Both of these measurements are taken by an FIA-homologated fuel-flow sensor installed in the car (see right). These components are purchased by the teams from a British company called Gill Sensors.

Teams encountered problems with the accuracy of these sensors during pre-season testing, and there were frequent discussions with the FIA about how to deal with fluctuations in the readings, which exposed teams to the risk of exceeding the limit.

FIA and team evaluation of the sensors discovered that individual sensors fell into two camps — they were either wildly out or fell within a very narrow band of accuracy. The inaccurate meters were discarded, and teams have been left free to choose the most accurate ones they want from the better examples. These are individually calibrated to the team’s fuel usage to become the standard by which the FIA measures the fuel-flow rate.

**WHAT HAPPENED IN OZ**

Red Bull’s problems began on Friday, when the sensor on Ricciardo’s car gave a different
reading from his fourth stint in first practice compared to his three earlier runs. The team elected to change the component for final practice and qualifying, but both Red Bull and the FIA were not satisfied that the new one was accurate.

Red Bull was asked to revert to the unit it used on Friday, which in the race gave the same readings as it had in the final run of FP1 and in all of FP2. The team did not believe in the accuracy of the reading it was getting from the sensor during the race, so elected to base its fuel use on its own fuel-flow model, rather than the FIA’s.

**FIA INSTRUCTION IGNORED**

There is scope in the regulations for teams to prove that they complied with the regulations from their own fuel data, but this is only allowed when the FIA decides that its fuel-flow sensor is either wholly inaccurate or not working. In Red Bull’s case last Sunday, the FIA did not believe the sensor was inaccurate. So when the live data available to the FIA technical team from its fuel sensor showed that Ricciardo’s car was breaking the fuel-flow limit, it advised the team to turn down its flow to comply with the regulations. The team ignored the request.

Red Bull’s refusal to follow the FIA’s instructions and stick to its own readings meant it ‘consistently’ broke the 100kg/h fuel-flow rate, according to the sensor. That left the FIA with no choice but to exclude Ricciardo from the race.

Red Bull was swift to appeal, as it felt it had complied with the regulations, even though the team had no instruction from the FIA to use its own data. The FIA courts must now decide if correct procedures were followed and whether Red Bull broke the rules.

As AUTOSPORT closed for press no date had been set for the appeal, which will likely take place at the FIA’s Paris headquarters. ☝️

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**2014 FUEL-FLOW RULES IN DETAIL**

To enforce the fuel-flow regulation of 100kg per hour, the FIA uses an ultrasonic sensor that gauges the mass of fuel passing to the engine and feeds the data to the FIA and team. The sensor is contactless to ensure it does not restrict fuel flow.

With the sensor designed to be accurate to within a fraction of one per cent, the FIA can apply a ‘correction factor’ to bring it into an acceptably accurate range. This was done in Australia, with the FIA changing the frequency of the sensors from 5Hz to 10Hz.

Even if the sensor fails it is still possible to calculate the fuel flow via readings from the fuel pressure and injector timings. This is not as accurate as the sensor, but does at least provide a reserve option.

The FIA therefore has to take the sensor – plus its correction factor – and/or a calculated fuel-flow reading as the *de facto* measure for a car.

*Craig Scarborough*
2.15 **RED BULL RB10 - Y100 WINGLET / MONKEY SEAT / BEAM WING SLICE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Red Bull Racing have arrived at Melbourne on the back foot, problems during the pre-season tests curtailed the mileage covered by the team, scuppering their assessment of aerodynamic solutions.

The team therefore arrived in Australia with several new components or with components that only had limited pre-season testing. In the case of the latter of these two is their Y100 Winglet / Monkey Seat which sits astride the crash structure. Whilst other teams have placed their Y100 Winglet's above the exhaust to try and influence it's upwash, Red Bull have placed theirs below. This should have a marked effect on how the exhaust flow influences the aerodynamic connection between the Diffuser below it and the Rear Wing above it.
2.16 **RED BULL RB10 - HIDDEN NOSE CAMERA'S**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Red Bull Racing arrived at Melbourne on the back foot, problems during the pre-season tests curtailed the mileage covered by the team, scuppering their assessment of aerodynamic solutions.

One of the standout exclusions by the team during pre-season testing was the placement of the FOM camera's on the side of the nose. Several conclusions had been drawn but although I'd thought about what we now see as Red Bull's plan I scoffed at the morality of it. However as we have seen over the years if the rules are ambiguous the teams will take advantage. The regulations that pertain to the new nose camera positions were to create further aero neutrality than had been seen in recent years, with teams using the camera housings over the last few seasons to make gains.

For instance teams would mount the camera housings in between the pylons and behind the main planes neutral centre section. This is an area of the car that the FIA have desperately tried to limit the aerodynamic capability of due to the net effect that can be seen downstream at the diffuser. Placing the cameras in a certain way offered some teams an advantage. Red Bull played with the housings in several positions throughout the last ruleset with the aforementioned one of these an option, whilst the 'hammerhead' position (placed either side of the noses tip) was another favourite. This not only created a desirable aero structure off their outer edge but also created a little more front end downforce with which to balance the car.
As we have seen in Melbourne, Red Bull have chosen to run their cameras mounted within the nose, which for many will be seen as a clear smack in the face to the regulations. However I can confirm the legality of what has been done by the team as 20.3.1 (technical regulations) states:

Referring to Drawing 6, all cars must carry (i) a camera in position 4 and (ii) a camera or camera housing in positions 2 (both sides), 3 and either 1 or 5.

Article 20.3.4 takes care of the new dimensional constraints designed to limit the placing of the cameras:

20.3.4 When viewed from the side of the car, the entire camera (or dummy camera) in position 2 shown in Drawing 6 must lie within a box formed by two vertical lines 150mm and 450mm forward of the front wheel centre line and two horizontal lines 325mm and 525mm above the reference plane.

What this article fails to take into account is the positioning of the camera(s) from the cars centreline and therefore allows the placement of the cameras within the nose itself.

I guess you're wondering why only one camera has been made visible by the team and I refer you to the rest of article 20.3.4:
Any camera or camera housing fitted in the left hand position 2 shown in Drawing 6 must be mounted in order that its major axis where passing through the centre of the camera lens (or corresponding position for a camera housing) does not intersect any part of the car lying forward of the camera or camera housing.

The opening in front of the left hand camera therefore brings the team inline with this regulation, whilst the regulations mean the right hand side can be covered minimising any additional aero deficiencies.

Lastly I suspect you're wondering how it's possible for the team to have a hole placed in this position on the nose, this falls under the regulations pertaining to vanity panels (a remnant of the 2013 regulations to hide step noses). You'll note a small bump has appeared on the RB10's nose just ahead of the camera peephole and this is due to the inclusion of the vanity panel. The bump isn't a dramatic aerodynamic issue for Red Bull due to their inclusion of the rear facing 'S' duct which will aid in the re-attachment of the airflow as it passes over the bodywork (Coanda effect).

Whilst it would be easy to imagine that the team would have to place the entire camera housing within the nose, all they need do is place the camera's within, this will also have a marginal weight saving (1.2kgs in total or 0.6kgs per housing).

I'm quite sure some of the other teams will be looking at this as a means of disposing of their own camera housings but this will rely heavily on if they are trying to leverage an aerodynamic advantage from their current position (Mercedes and Ferrari).
2.17 **RED BULL RB10 - REAR WING SUPPORT PYLON AMENDMENT**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Red Bulls approach to the regulation changes surrounding the rear wing involved the team running a centralised pylon mounted to the engine cover (left inset). (Unlike other teams that had run with an inverted Y-Lon, which is to say that a surround is placed over the exhaust outlet providing a more rigid fixing point to be established above the gearbox).

This has changed in Melbourne with the team making revisions to both the cooling outlet and centralised pylon. Following McLaren and Marussia's lead an inverted Y-Lon can now also be found on the RB10, however the Red Bull version is masked by the end of the cooling funnel outlet with the pylon extending through the top of the bodywork and is affixed to both the upper and lower sections of the cooling funnel.

The upshot is a more efficiently packaged pylon that doesn't drastically impinge on the external aero but adds a little more rigidity over it's predecessor and likely aids in the internal airflow characteristics (drawing the airflow through the cooling funnel like an aspirator).
2.18 Red Bull RB10 - Rear Wing Gradient Slots

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Red Bull Racing arrived at Melbourne on the back foot, problems during the pre-season tests curtailed the mileage covered by the team, scuppering their assessment of aerodynamic solutions.

Several elements stood out during the testing phase as being devoid of their usual refinement with the rear wings endplates being one such example. Usually you'll find a set of louvres placed in the upper front section of the endplate (see lower left inset). Their job is to allow pressure to move either side of the endplate which in turn maximizes the efficiency of the Wing (more downforce, less drag). Furthermore most of the teams on the grid, including Red Bull had converged on the idea of using a tyre wake slot on the lower leading edge of the endplate (lower left inset). It's job was to create aerodynamic stability and was also missing from the RB10 when the team tested pre-season.

With aerodynamic efficiency even more prominent this season it was surprising not to see these elements on the RB10 in testing but in Melbourne we get to see why. The team have added 3
gradient slots to the Endplates (bottom right inset) which follow the curvature of the rear wings main plane and top flap, these slots combine the principles of the leading edge variants previously used (upper louvres and lower tyre wake slot) and likely lead to an overall more efficient solution. Pressure from outside the endplate migrates inside untwining with the tip vortex to reduce drag whilst yielding the same if not more downforce through virtue of the injection of airflow pulling the airflow around the wing planes (Coanda). As always Red Bull are playing a game where Peter robs Paul, in order to increase the aspect ratio of the wing under different conditions. I expect this to be an area of development as the season unfolds.
2.19 **RED BULL RB10 - DIFFUSER**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

The diffuser has been an area exploited by the Red Bull team over recent seasons with them exploring the use of blowing it's outer edges (2010-11 Exhaust Blown Diffuser and 2012-13 'Coanda' exhausts). With this practice curtailed in 2014 by the centreline placement of a single exhaust outlet it's no surprise to see changes in this area.

For Melbourne the team have revised the inner vertical strakes, adding slots to the lower section of the elements, the strakes also feature a more aggressive curvature ahead of the slots which will manipulate the way in which the air flows around them. The strakes purpose is to aid the diffuser in yaw, creating pockets for the airflow to collate, maximizing the performance of the diffuser in its entirety. The slots will allow airflow to bleed off under rotation, further maximizing the pressure gradients at play.
During pre-season the team have also been utilising some small Vortex Generators at the transition between the flat section of floor that houses the plank and the upward curvature of the Diffuser. These were used in Melbourne and are a likely response to the loss of the starter motor hole as a way of injecting airflow into the central portion of the Diffuser. The Vortex Generators will aid in overcoming the sharp transitional incline, allowing the airflow to operate more effectively over a wider speed threshold.
2.20 **Key Tech Tweaks on the Red Bull RB10**

2.21 **RED BULL DEBUTS NEW DRAG CUTTING REAR WING ENDPLATE**

[by Steven De Groote from http://www.f1technical.net]

Among the many updates present on various cars at Melbourne, Red Bull certainly has one of the more interesting as the RB10 features a brand new rear wing endplate, including a new solution to reduce the drag induced by the rear wing.

The previously common solution, as seen on the inset, was to add gills on the high pressure side of the rear wing. These gills allowed some air to bleed off from the high pressure area in between the endplates to end up on the outer sides of the endplates. Red Bull's new endplate lacks these gills, instead adding 3 small apertures on the low pressure side of the rear wing. Here, air from outside the endplates flows through these openings into the low pressure area under the wing.

In both cases, downforce generated by the rear wing is marginally reduced, but the return is a less strong vortex on each side of the rear wing, resulting in less drag. What triggered this new design is unclear, but it is not unthinkable that the stronger DRS system has something to do with it.
Lotus, like the rest of the Renault teams arrived in Melbourne on the back foot, with power unit issues the predominant reason behind their pre-season issues. Lotus having missed the first test in Jerez however have even less testing mileage under their belts and so would really be using Australia as a stepping stone in terms of launching their campaign.

The team arrived in Melbourne with a new Front Wing, amending some of the details that are key in addressing the new regulations. With the Front Wing 150mm narrower for 2014, turning the airflow around and over the front tyre has become much more critical. This is because the wheel wake can then compromise the aerodynamic performance of the Sidepod and Floor aft of it as it tries to rejoin with those airflow structures. In order to address some deficiencies the team must have found in their original design in testing, the time arrived with a new design. It features an elongated outer arc to the main plane [1], with a strake mounted centrally underneath the wing, which leads to a change in the profile of the footplates arc [2] both of which are used to create elongated vortices that feed around the outside of the tyre. Meanwhile the top flap has an additional support spar added [3], a reduction in the length and
thickness of the adjuster [4] and the outer section of the top flap now features a section that stands off the flap giving a steeper angle of attack [5].
2.23 **LOTUS E22 - REAR WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The rear wing has been amended with the inclusion of 4 strakes on the endplate, having been used on it's predecessor it's no surprise to see them added. This time though the strakes are deliberately much larger and look to make use of the airflow dissipated by the tyres and other surrounding airflow structures. The strakes help manage the direction of the airflow and will assist in creating upwash, a desired effect that'll help to create an aerodynamic link between the diffuser and rear wing planes which has been reduced this season with the loss of the beam wing.
2.24 **LOTUS E22 - ASYMMETRIC FLOOR DUCT**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

As we know Lotus have struggled in pre-season not only with their missing of the first test in Jerez and the lost mileage that ensued but also the lack of mileage covered at the following two tests. The team will then perhaps be buoyed by the fact they managed to complete 29 and 43 laps with Maldonado and Grosjean respectively, both of which found their race curtailed by ERS issues.

An interesting development from the team arose throughout the weekend and highlights another area of asymmetry on the E22. The team have enveloped a duct into left hand side of the floor, mid way along the Sidepod (for reference). It's actual purpose is unclear at the moment but due to it's positioning is likely a further cooling option with aerodynamic implications rather than simply an item placed with aero intentions.

Above: A close up of the left hand side of the floor shows the duct
The forecast Technical Files
http://www.f1-forecast.com

Above: As we can see the duct is nowhere to be found on the right hand side of the E22

My best guess would be that the team are seeking a way of dispatching of some of the heat generated by the ERS heatsinks. (Explained here: Explaining 2014’s Power units & ERS) Managing the energy that is recovered is a massive task with the transfer of energy between the MGU-H or K to the Energy Store comes at a cost: Heat.

The placement of the duct is interesting as it's perhaps a carry over from a lesson learnt in 2013 with the teams exhaust cross-under tunnel. My understanding of the way the tunnel worked was not only to do with the local airflow structures adhering to their surfaces and the ensuing 'Coanda' effect but was also a result of the front wings flow structure and front tyre wake. The airflow dispatched by the front wing is done so in order to control the direction of the tyre wake, however it will at some point make efforts to rejoin the airflow structure at the edge of the floor.

Many teams use 'Scrolls' which are a rolled up section of floor that protects the airflow traveling around the sidepod from unwanted tyre wake. The new floor duct lies in a position normally associated with the scrolls and so we have to assume it's making use of this tyre wake. The narrowing of the front wing by 75mm either side has had a marked effect on the aero and so some teams are making a marked effort at moving the airflow further outward to counter the
effects both locally and downstream. With Lotus having run a new front wing in Australian designed at just this I suspect they are targeting their efforts at aligning the flow around the duct.
2.25 **LOTUS E22 - ENGINE COVER (TRIAL OF THE 'SHARK FIN')**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

The E22 render that the team originally released showed the car with a 'shark fin' engine cover which up until Melbourne had failed to materialize. The team sacrificing the aerodynamic performance of that style of engine cover for the cooling option of a larger outlet funnel and inlet's and outlets surrounding the turbocharger to keep it cooled. The 'shark fin' was only used briefly during the weekend and can be seen in the image below (the engine cover used otherwise can be seen in the upper left inset).

A discrepancy between both cars for the race is the lack of cowling covering the turbo cooling outlet on Maldonado's car. It appears that this wasn't a conscious decision by the team and was actually lost when Maldonado ventured off into the gravel, due to Parc Ferme restrictions he had to continue with out it and would be interesting to know if this had some impact on the lower mileage covered by the Venezuelan during the race.
Above: Maldonado sits at the end of the pitlane with his turbo outlet cover MIA
Above: Maldonado takes a trip into the gravel and likely dislodges the turbo cooling outlet cover
2.26 **McLaren MP4-29 - Turning Vanes**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Basking in the opportunity to run significant mileage during pre-season testing, McLaren were in good stead heading to Melbourne. Having made some significant errors with the '28' the team are eager to show their worth with the new car.

One of the early season changes the team made in 2013 to try and rectify some of their issues was reverting to a more basic Turning Vane configuration. During testing the team used a similarly basic set of vanes placed under the nose, whereas in Melbourne the team arrived with a 3 tier arrangement.

The movement of these vanes is indicative of the way in which the team see the tyre wake affecting this portion of the car with the new vanes moved rearwards. The first element is attached to the most rearward underside portion of the nose whilst the two secondary elements are affixed under the chassis. The mere fact they are now a triple element rather than a singular one means that they should operate more efficiently over a wider speed range, with airflow bleeding between the elements as it passes by.
2.27 **TORO ROSSO STR9 - INVERTED Y-LON REAR WING SUPPORT (UN-RACED)**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The loss of the beam wing for 2014 has led to many different solutions from the teams this season, Toro Rosso approached it by strengthening the endplate supports and the way they're affixed to the floor. Many of the other teams (including their sister team) have opted for supports that run centrally to the underside of the main plane. These supports will of course add structural integrity but compromise the aerodynamics especially where the support meets with the underside of the main plane and so it's a catch 22 situation.

During the Free Practice sessions in Melbourne the team looked at the singular inverted Y-Lon option used by McLaren and Marussia when they launched their cars and now finds it's way onto the RB10 (albeit in a slightly different guise). It wasn't retained for qualifying and the race but goes to prove that the team are eagerly assessing other avenues. The circular section that surrounds the exhaust is of particular interest to the teams assessing it's merits as it can help accelerate the airflow forward of it, be it being dispatched from the cooling outlet or over the engine cover. I suspect the team will re-assess it's use over the coming GP's.
2.28 **FORCE INDIA VJM07 – MINOR REVISIONS ON REAR WING**

[F1 tech and art Blog by Michalis K [Bar555] : http://formula1techandart.wordpress.com]

Force India proceeded on minor rear wing revisions for the Aussie race weekend. The changes involved the number of wing’s flap fatheners, the number of which now reduced to two from three.
2.29 **CATERHAM CT05 - NEW FRONT WING**

[CatersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Caterham like the other Renault powered F1 teams suffered with reliability issues throughout pre-season testing. The team encountered further issues throughout the weekend in Melbourne and Kamui Kobayashi even changed his Energy Store, meaning he only has 4 remaining before he would take a penalty to change one.

Even so the team still had aerodynamic changes for the CT05, albeit with the new front wing only run on Kobayshi’s car for qualifying/race. As we can see the changes come in the form of a new outer cascade element (reminiscent of the 3 tier one used on the Williams last season), Ericsson’s car (upper right).
2.30 **CATERHAM CT05 - REAR WING SUPPORT PYLON**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The changes that now prohibit the use of a Beam Wing have led to teams trying different solutions in order to retain the same or similar level of structural integrity, whilst trying to mitigate the aerodynamic effects.

Caterham arrived in Melbourne with a new configuration and ran it throughout the weekend, the older specification utilised two pylons mounted either side of the crash structure and widened to take into account the exhaust, then terminated at roughly 200mm apart at the underside of the main plane.

The new arrangement (below) still comprises of two elements emanating from the top of the crash structure but these now bellow out to surround the exhaust before converging above it to form a singular pylon that meets centrally with the underside of the rear wing. In terms of structural integrity I’d suggest that both options offer similar performance with the new iterations a little bulkier. The aerodynamic implication however is that with only the centralised pylon (inverted Y-Lon) the interaction with the rear wing’s main plane is minimized increasing
it's performance. You'll also note that the Y100 Winglet / Monkey Seat has been redesigned with the new version featuring no endplates, whilst it's mounted from the pylon on a swan neck support similar to the one used by the team in 2013.
2.31  **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images in Melbourne courtesy of [Sutton Images](http://www.suttonimages.com)

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**Force India VJM07 - Detail shot includes the front brake and duct, stepped chassis and Splitter support mechanism**
Sauber C33 - Sidepod detail (note the now universal impact protection spar)
Force India VJM07 - Front Wing detail
The F1-Forecast Technical Files
http://www.f1-forecast.com
Force India VJM07 - Nose detail shows how the nose curves away after the mandated 50mm rear of the tip cross section
Sauber C33 - Nose and Front Wing assemblies
Toro Rosso STR9 - New and old Nose and Front Wing configurations, older specification on top with the newer one used at the last pre-season test featuring higher arcs either side of the 'finger' protrusion. This will allow more airflow to pass under the nose toward the chassis. Meanwhile you'll note that changes to the Front Wing come in the form of a 3 instead of 2 tier outer cascade and the outer portion of the top flap has been amended.
Toro Rosso STR9 - A close up of the aforementioned increase height either side of the finger extension
Marussia MR03 - A close up of the nose tip shows how quickly the tip retracts back whilst the angle also shows off well the outer 7 tiers to the wing.
Sauber C33 - Front Wing detail (marked changes for 2014 include an additional tier and straight Endplate)
Force India VJM07 - Rear end detail, great shot of the car without the floor/diffuser attached
Marussia MR03 - Front Wing / Nose
Toro Rosso STR9 - Front Wing / Nose
Sauber C33 - Front Wing / Nose
McLaren MP4-29 - Sidepod bodywork, note the change in livery includes a new black element
Marussia MR03 - Nose and Front Wing detail
Williams FW36 - Nose and FW pylon detail shows how the pylons are twisted to maximise their aerodynamic effect (Also note the new anniversary Senna logo which replaces the 'S's placed in this position since 1994)
Williams FW36 - Rear End detail
Sauber C33 - Front brake assembly detail
Mercedes W05 - Rearward shot of the chassis presents us with a view of the conjoined lower wishbone which has been implemented for its aero advantage, under chassis turning vane, which although it's a single element features 2 vertical perforations turning it into a 3 element vane. Whilst it's lower section forms a horizontal section that will form a Vortex shielding the crucial airflow passing under the nose from the tyre wake.
Red Bull RB10 - Mechanics prepare the car ahead of this weekends action
Mercedes W05 - Detailed shot of the bare front end of the car during preparation
Ferrari F14T - Detailed shot of the bare front end of the car during preparation
Lotus E22 - Detailed shot of the bare front end of the car during preparation
Lotus E22 - Detailed shot of the bare front end of the car during preparation
Marussia MR03 - Front Wing / Nose stack
Caterham CT05 - Nose and Front Wing, note the team have now painted the 'finger' extension to try and hide the aesthetics of the nose
Mercedes W05 - Front Brake assembly (Note the crossover pipework is used to cool the caliper)
Red Bull RB10 - Brake Housing (Cake Tin)
Ferrari F14T - Front Wing Endplate from the original 3 tier wing used during testing at Jerez and Bahrain
Ferrari F14T - Rear Wing
McLaren MP4-29 Front brake assembly
Force India VJM07 Chassis detail (note the sloped underside to meet with the dimensional criteria)
Force India VJM07 Rear Wing
Force India VJM07 - Front brake assembly
Sauber C33 - Chassis detail, note the cut away section ontop of the bulkhead leading to the use of a vanity panel to make up the height differential
Sauber C33 - Front brake assembly
Toro Rosso STR9 - Chassis detail
Toro Rosso STR9 - Front brake assembly
Williams FW36 - Rear brake assembly
Williams FW36 - Chassis detail
Marussia MR03 - Front brake assembly
Marussia MR03 - Chassis detail
Ferrari F14T - Front Wing detail from behind, note this is the 7 tier wing
Mercedes W05 - Front Wings on their setup trestle with a new configuration at the bottom (new Endplates and Cascade arrangements)
Mercedes W05 - Twin Floor Strake and Tyre Squirt Slot arrangement as tried at the last pre-season test
Mercedes W05 - Slotted and twin element Bargeboard with a Twin element Sidepod Airflow Conditioner where the rear element reaches over and meets with the vertical vortex generator above the sidepod.
Mercedes W05 - New Splitter as tried at the last pre-season test in Bahrain
Mercedes W05 - rear end detail (note no Gurney Trim on the sidepod air outlet)
Williams FW36 - rear end detail
Sauber C33 - Front Wing from the underside
Mercedes W05 - 'Bat Wing' named for obvious aesthetic reasons this is mounted as part of the ride height sensor that sits in this position on all the cars. It utilises and re-purposes the vortices created ahead of it.
Mercedes W05 - Rear end detail (Note the use of a blanking section within the 'U' bend
Mercedes W05 - Rear shot of the front edge of the floor shows the 2 element Bargeboard that's leading element is also slotted
Red Bull RB10 - Front Brake Assembly (no disc attached, note the lower duct that cools the caliper)
Mercedes W05 - Roll Hoop / Airbox (Note the additional snorkel inlets added either side of the airbox for additional cooling)
Ferrari F14T - Nose from the side, note the forward sections of the Turning Vanes are attached to the nose whilst the rear section will be affixed to the underside of the chassis.
Ferrari F14T - Front brake assembly
Williams FW36 - Airbox detail (Note the air outlets at the airbox's base, furthermore note the vortex generating wing mirror mounts)
Ferrari F14T - Chassis detail (note the rear portion of the Turning Vanes that match the ones attached to the nose mentioned earlier)
3. **ROUND 02/19 – MALAYSIA**

3.1 **COOLING F1 CARS IN THE TROPICS**

[by Craig Scarborough from http://www.autosport.com/f1]

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**Craig Scarborough reveals some of the secrets of how teams keep their cars cool**

Every racing car must cool its powertrain. As Formula 1 cars become more complex, this job has become increasingly difficult, particularly when you are racing in the extreme heat of Malaysia. Cooling affects power outputs and reliability, but also chassis and aerodynamic performance.

A large part of the work for the teams in the lead up to the season was designing an adequate cooling system. Packaging this much cooling into a F1 car has brought many different approaches and innovations. Luckily for the teams, the downsized petrol engines now push out less heat than the old V8s. Yet still the 1.6-litre V6 needs both water radiators and an oil cooler for efficiency. These are about half of the size of the 2013 coolers.

The turbocharger needs to be cooled internally by oil, as well as by airflow around its red-hot exterior. The air compressed by the turbo also needs cooling before going into the combustion chamber. The intercooler that cools the charge air is big enough to fill a sidepod on its own.

The upscaled Energy Recovery Systems (ERS) need even more cooling. From a modest water radiator about the size of a packet of biscuits for KERS in 2013, the 2014 ERS needs nearly as much water cooling as the petrol engine. In order to keep the temperatures low enough for the electronics, the ERS cooling runs a separate water circuit to the engine.

Lastly, the gearbox oil still requires cooling. The gearbox is more heavily-stressed this year, with more torque from the engine and service life extended to five races.

Such demands require, on average, five or six different coolers, each mounted inside the bodywork forming the sidepods and engine cover. Each cooler will need a stream of cool air, but inlet aero costs drag so teams will want to minimise any openings.

Then the heated air needs to find an exit into a low-pressure area and in a place where aerodynamic performance isn’t compromised. Complicating this are regulations that restrict where openings can be made in the sidepods. Teams have to find small areas exempt from this, such as beside the cockpit and chimneys at the front of the sidepod. Heated air will have to move forwards inside the ‘pods to reach these outlets, aided by the pressure difference between the two areas.

This cooling package needs to be tailored for each track to cope with different ambient temperatures and aerodynamic considerations.
**COOLERS**

- Engine oil cooler
- Gearbox oil cooler
- Turbo intercooler
- Engine\ERS water radiators

**AIR FLOW**

- Hot air outlet
- Cooling air inlet
3.2  **FERRARI F14T - ENGINE COVER COOLING OUTLETS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Although this isn't a new development for Ferrari it is the first time the team have raced the additional cooling outlets which reside on the spine of the engine cover. With temperatures soaring in Malaysia the teams have to make some additional allowances when it comes to cooling.

The team continued to utilise the larger engine cover cooling funnel used in Melbourne but this time they've utilised more outlets which run down the spine of the cover along the shark fin. These help to alleviate the heat generated by the turbo which also has an inlet further up the cover to allow cooler air in.
Ferrari strikes a spinal chord

Ferrari has the flared bodywork opening around the exhaust, but it has also taken an interesting approach with the back of the engine cover.

It has added a series of small louvres that run down the spine of the engine cover, instead of having a large hole as it did last year. These work quite well because you can keep the surface airflow attached. The risk if you don't do this is that you can end up sucking the airflow that is meant to stay outside into it. Years ago, Williams had this problem on one of its ground-effect cars with a radiator duct in the sidepod that was allowing airflow in to get sucked under the floor.

The louvres create a surface for the airflow to attach to and ensure that the exit facing rearwards is connected to the low-pressure area at the rear of the car to pull air through. It's an elegant solution.
3.3 **MERCEDES W05 – COOLING FLARE**

3.4 **RED BULL RB10 – NEW REAR WING**


Red Bull sports new rear-wing upgrades

**RED BULL INTRODUCED A REAR WING WITH**
new endplates and a modified support pillar in Malaysia.

**GARY ANDERSON:** “This is an interesting change.
The usual louvres you see in the endplates are on the
top surface of the wing (inset right). They allow the high
pressure there to spill through to the outside of the wing.
This reduces the high pressure that triggers the vortex
off the top rear corner of the wing endplate, which
creates drag. You lose downforce but gain efficiency.

“But Red Bull has put three louvres in the endplate
connected to the undersurface of the wing (black
arrow). The low-pressure area under the wing will drag
more air through these louvres to improve efficiency.

“Red Bull has also tidied its rear-wing support pillar.
Before it was a longer cord and leaned forward, but this
has been refined with a longer cord base reducing as
it rises up to join the underside of the wing. This will
disturb the airflow to the undersurface of the wing less.”
3.5 **McLaren MP4-29 - Double Floor / Sidepod Duct**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

As we have seen throughout pre-season testing the teams have already assessed a multitude of options to keep their cars cool. The problem however is as soon as you start opening up bodywork it has an impact on other aero structures, usually leading to a rise in drag due to the way the hot, slower airflow interacts with the flow regimes. With efficiency always being a prime concern McLaren arrived in Malaysia with a new sidepod and floor arrangement that is reminiscent of the one trialled by Lotus in Melbourne.

Unlike Lotus though, McLaren have the ducts present on both sides of the car dispatching hot air from the car into a region that it can be better utilised and re-purposed. The duct is formed by an additional section of bodywork that sits above the floor which connects to the Sidepod, this duct resides between the two floor scrolls which will undoubtedly work in unison with the duct to re-energise the airflow. Meanwhile the entwining of a vortex in this region in itself will create some drag, the upshot however is that the vortex could help to protect the floor from the wake produced by the front tyre.

The increase in heat being generated by this years power units is predominantly due to the increase in electrical energy transfer. KERS capacity was 400kj per lap whilst the ERS can store...
upto 4mj's per lap, energy is harvested in AC (alternating current) but to be stored needs to be converted to DC (direct current). A byproduct of this exchange is the generation of heat and is likely what McLaren are looking to alleviate with these ducts.
3.6 **MCLAREN MP4-29 – NEW NOSE**


McLaren introduced a modified anteater nose at the Malaysian GP, in addition to the new front wing assembly that was used at the Australian GP. GARY ANDERSON analyses the changes:

**Front wing changes (Australia)**

1. This is a smoother transition to the endplate, whereas the original was very abrupt. An abrupt change can cause airflow-separation problems.
2. The upper forward wing has been simplified to a bigger, one-piece component.
3. This is a ski ramp, similar to the one Mercedes ran last year. The aim is to turn airflow over the tyre.
4. It has moved to a smaller turning vane solution.

**New nose (Malaysia)**

5. The nose is raised near the Mobil logo to the maximum allowed height in the 2014 regulations.
6. The new nose section is higher and further rearward, with a revised ‘anteater’. This is designed to get more airflow under the nose to the floor.
7. Like Ferrari, McLaren has introduced a bigger radius on the top corner of the nose, which then blends into a smaller radius where it joins the chassis. This allows airflow to spill off the top surface of the nose.
8. The front-wing mounting pillars are more curved, turning the airflow outward more aggressively.
3.7 **LOTUS E22 – NEW COOLING CONCEPT**


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Lotus tries new cooling concept

The lower red arrow indicates a hole extracting air out of the sidepods of the Lotus. The regulations allow openings up to 100mm above the reference plane. This is about 50mm from the step plane, which is itself 50mm above the reference plane. This will aid the cooling of whatever is in the sidepod.

I'm not 100 per cent convinced it's to help the radiator because it's too far forward to assist with radiator cooling. Perhaps it's for the electronic control units of the ERS, which is logical considering the problems Lotus has had. But it will hurt car performance because most cars have a turned up section on the outer edge of the floor to act as a trip to make sure you get more downforce from the front part of the underfloor; this doesn't allow that to happen.

The upper red arrow indicates four louvred holes to help the cooling of the front of the radiator.
3.8 **WILLIAMS FW36 - ENGINE COVER OUTLET**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

During pre-season testing it appeared that Williams were following the same distinct packaging solution at the rear of the car that its predecessor had used. This was a distinct difference to the rest of the field with the Williams cars using a huge lower outlet releasing hot, lower energy airflow into the section below the beam wing. This meant that the engine cover itself was shorter longitudinally making it easy to see just how little resided above the gearbox on the car. The shark fin dominated aesthetics as it was only placed on the engine cover to meet the dimensional constraints within the regulations.

The increased complexity and packaging of the new power units has forced all the teams to rethink how they cool the cars for 2014, especially with the turbocharger now residing (or at least half of it) after the engine. As we can see from pre-season (upper right) when compared with the main image the lower engine cooling exit is now shaped like an inverted lotus (the flower not the car) rather than the half moon it previously utilised. This is to take advantage of the shaping at the rear of the sidepods which now become part of the aerodynamic structure, rather than having their own flow regimes. As we can see from the main picture it also appears the team were using a perforated gurney trim on the trailing edge of the cover. This will of
course create some localised drag but the lower pressure in behind the gurney helps to pull the airflow below (in this case slower moving, warm air that has passed through the car). The perforation acts as it does with the diffuser gurney trims we have seen the teams use for several years now, allowing a small quantity of airflow to filter into the low pressure zone, minimising the drag component.

The new cooling cannon (central outlet through which the exhaust extrudes) is actually a further reshaping of the cover that surrounds the gearbox and acts as a nozzle on the airflow. As we can see from the upper left inset the team actually trialled a gurney on it's periphery too, albeit with no perforation.
3.9 **SAUBER IS OVERWEIGHT**


Sauber drivers Adrian Sutil and Esteban Gutierrez have revealed the team’s car is too heavy during last weekend’s Malaysian GP. The C33’s customer Ferrari engine is understood to be over the minimum power unit weight of 145kg, and the team has been unable to get down to the overall minimum weight limit of 692kg (raised by approximately 50kg for 2014).

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**BRAKE WEIGHT SAVING**

**GARY ANDERSON:** “The usual brake system pre-2014 featured a six-piston caliper front and rear. Because of the brake-by-wire system, most teams have gone much smaller on the rear discs and calipers. Sauber, like Red Bull and others, have gone to a four-piston caliper because 15 per cent of the braking is done by the electric motor. The caliper is, at most, a 200g weight saving at each rear corner.”
3.10 **TORO ROSSO STR9 - REAR WING SUPPORT PYLON (Y-LON)**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Toro Rosso briefly tested the use of an inverted Y-Lon in Melbourne and it seemed the team were going to make do without it in Malaysia too with the team doing plenty of running without either the Y-Lon or their Y100 winglet used during pre-season adorning the car.

For qualifying and the race however the team re-installed the Y-Lon which also required a change of rear wing profiles, mitigating some of the loss as it connects with the underside of the main plane. In reality, one of the most intriguing sections of the Y-Lon is not it's installation in order to increase rear wing rigidity but the lower cylindrical elements impact on the surrounding airflow.

Surrounding the exhaust would seem to be it's primary purpose but the shaping, orientation and it's offset from the engine cover means it should work in unison with the exhaust to pull airflow through and over the engine cover, once again utilising the exhaust to influence airflow.
3.11  **Why F1 2014 is Louder Than You Think**

[by Ben Anderson from http://www.autosport.com/f1]

noise has long been a big issue for motorsport in general, but it has also become a serious talking point in Formula 1 over the first two races of the new season.

There was a degree of backlash from fans following the first race of 2014 in Australia, as those used to the piercing scream of high-revving V8 engines suddenly found the soundtrack to their Sunday viewing altered substantially by muted V6 turbo propulsion. But it is not only a proportion of enthusiasts who have found this quieter form of F1 a turn-off. First the sport’s commercial supremo Bernie Ecclestone told the Australian press that he was “horrified” by the lack of noise in Melbourne (despite not actually being there himself), then reigning world champion Sebastian Vettel waded into the debate in the build-up to the Malaysian Grand Prix by claiming the latest F1 engines sound “shit”. Other drivers have been less outspoken, although McLaren’s Jenson Button pointed out that most are only concerned with how competitive their machinery is, not what it sounds like. “When you cross the finish line first you don’t care what it sounds like,” he said. “You have beaten the best in the world and that’s all you care about. Go and race something else if you’re not happy.”

Interestingly, Ecclestone subsequently softened his opinion after seeing — and hearing — the cars up close for the first time in Malaysia. And that is a crucial point, for it seems there has been a serious disconnect between what the cars actually sound like and how they come across on TV and radio.

As Professor Trevor Cox — an expert in audio engineering from the University of Salford — points out, this new generation of F1...
“Ears are sensitive at V8 frequency. That ‘screaming’ sound is also a distress cry”

The irony is that if you look at videos from 2013, lots of people are wearing ear defenders, which will knock off 20-30dB depending on their quality, and that’s quieter than what is going into their ears now. “There’s an important psychological aspect too, related to the frequency of the sound. The old V8s produced a sound in the 500-2500Hz range, whereas the new engines fall an octave lower, to 100-600Hz. The old V8s were described as ‘screaming’ and the ear is very sensitive at that frequency. A screaming sound is also a distress cry, so it produces an emotional response in the listener.

“I’ve listened to some recordings of the new engines and they sound like older turbocharged racing cars. Part of this is about what we’re used to. It might sound glib to say people will get used to it, but that’s probably true for most.”

Beyond getting used to a different audio experience, perhaps the key to reaching fans who (understandably) are unwilling or unable to spend money on actually attending races is to better translate the sound to TV and radio audiences.

One TV insider, who did not wish to be named, told AUTOSPORT that better microphone placement and processing of the sound would improve the experience for armchair fans.

“The biggest thing lost from 2013 to 2014 has been volume,” he said. “I would suspect a drop of around 25dB to 30dB. This may not sound a lot but it’s pretty big.

“There’s also a tonal shift in the sound produced by the new cars. The mid to upper frequencies have been lost and, while the turbo whistle is there, it’s not enough to compensate for the loss of the sound of the V8.

“Given better mic placement, audio mixing and processing, the fans at home should get a much more precise reproduction of the sound at the track, although this can be tricky given the acoustics of each venue are different, and that sound is also affected by climatic conditions, so the cars could sound very different from day to day.”

Ultimately, it seems that fans will have to like it or lump it. For better or for worse, the sound of F1 has fundamentally changed, and there is no going back now.
3.12 **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)
A selection of the best technical images in Sepang courtesy of Sutton Images

McLaren MP4-29 - wide angle shot showing the new nose which features a shorter, more drooped 'finger section owing to the raised section behind which will allow more airflow to pass underneath the car and drive the floor
Mercedes W05 Front Wing detail (wing raced in Melbourne)
Williams FW36 - Side view shows the longer engine cover with upper cannon style cooling outlet rather than their usual much larger lower outlet and shark fin cover
Lotus E22 Side view
Sauber C33 side view
McLaren MP4-29 - side view
Force India VJM07 - side view
Red Bull RB10 - Front brake duct detail, note the scroll vanes that will collate the airflow dispatched by the front wing and re-purpose it
Red Bull RB10 - rear detail
Force India VJM07 - rear detail
Red Bull RB10 - front wing detail
McLaren MP4-29 Front wing detail and new nose configuration from the front
McLaren MP4-29 pitot tube array used during free practice to ascertain the impact of tyre wake around the bargeboard region.
McLaren MP4-29 new nose detail
Lotus E22 front wing detail
Lotus E22 front brake duct detail, note the proliferation of winglets on the top edge of the duct whilst the lower section is also treated to curved flow conditioners
Marussia MR03 - A flo-viz'd up rear wing, whilst the car is also devoid of the usual Y100 winglet showing the size of the inverted Y-Lon
McLaren MP4-29 rear end detail
Williams FW36 - enlarged central cooling cannon exit ahead of the Y100 winglet as trialled briefly in pre-season testing
Toro Rosso STR9 rear detail shows the team running without the previously trialled central inverted Y-Lon or the Y100 winglet
Williams FW36 - enlarged central cooling cannon exit ahead of the Y100 winglet as trialled briefly in pre-season testing albeit this time with a gurney trim that runs around its periphery
Ferrari F14T rear end detail, note the enlarged cooling cannon outlet as tested in pre-season for the increased heat in Malaysia, whilst the engine cover also features more cooling along the spine of the engine cover.
Lotus E22 floor detail
McLaren MP4-29 Front Wing detail
Williams FW36 Front wings, note the lower wing has a shallower top flap with an upstand to the outer section
Toro Rosso STR9 - Old nose and front wing configuration top, new nose and front wing bottom
Sauber C33 - New front wing at the top features a new shallower top flap whilst the outer section stands proud of the flap.
Mercedes W05 Rear wing, note the oil cooler that sits astride the gearbox and resides within the engine covers central cooling funnel.
Mercedes W05 Front wing, note the vortex generators on the second tier of the main plane sit ahead of the strakes behind the wing. These disturb the airflow increasing the strakes efficiency.
Marussia MR03 Front wing (7 tiers)
Toro Rosso STR9 - Rear wing central mounting pylon as tested in Melbourne
Mercedes W05 - Front wing from behind
Mercedes W05 Front wing from behind
Mercedes W05 - Under chassis detail (Splitter, Turning Vanes and Bat Wing)
Williams FW36 Front wing from behind
Lotus E22 - Checks made to the rear wings main plane and top flap
Mercedes W05 Front Wing (raced in Melbourne)
Mercedes W05 New Front Wing (tested in Melbourne but un-raced)
4. **ROUND 03/19 – BAHRAIN**

4.1 **2014 VERSUS 2013 IN BAHRAIN**

[Ferrari's Fernando Alonso criticised the latest breed of F1 cars for being too slow in the build-up to the Bahrain Grand Prix, and he wasn't the only one to express that view. But the reality is that 2014 F1 cars are much faster than they should be in relation to their predecessors, if you consider how much heavier they are.]

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**2014 VERSUS 2013 IN BAHRAIN**

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<tr>
<th>Pole Time</th>
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**Weight**
- 2013: 641kg
- 2014: 691kg

**Top speed**
- 2013: 195mph
- 2014: 204mph

**Pole time**
- 2013: 1m32.330s
- 2014: 1m33.185s

**Actual speed difference**
- Should be 1.6s slower at 1m33.930s

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**OUR VERDICT**
The cars are already close to 2013 performance in the right conditions and will only get quicker as teams refine their Energy Recovery Systems and recover downforce.
4.2  **THE PROBLEM OF FUEL FLOW, IS THERE ONE?**

[SomersF1 blog by Matt Somerfield: [http://somersf1.blogspot.co.uk]]

Formula One has yet to embrace the new era of racing it has found itself in and I have to question why? The biggest problem as with anything associated with F1 is conveying it to the masses, unfortunately everyone has done a relatively poor job of this, thus far.

I’m contacted all the time on twitter with people saying that the FIA should simply scrap the fuel flow limit they imposed of 100kg/h or raise it. But raise it to what? what is going to make a difference? My question however is 'Why should it be raised?' we are two races (writing this before the start of the 3rd race) into a new season with the largest set of regulation changes in the sports history. The technology being used is in its infancy and so therefore is the teams knowledge of how best to extract performance from it, this therefore suggests a knee jerk reaction from a crowd (Bernie, Montezemolo etc) that know little of how monumental Formula One's involvement in this technology is going to be.
An exchange of views between myself and Will Buxton on twitter today was the catalyst for this piece and so I'll try to take some of that exchange, along with comments from other twitter users and explain why the fuel flow limit is pivotal.

How fast do you want these things going in a straightline @willbuxton? They could rev out to 15k if they wanted now but no extra power
— Matt Somerfield (@SomersF1) April 6, 2014

The fuel flow limit was placed in the regulations for several reasons with the most important being the amount of power that could be generated by the ICE/Turbo if the flow of fuel was unrestricted. Imagine the fuel flow was un-restricted, as Will rightly pointed out in our conversation the regulations allow the ICE to rev to 15,000rpm but no-one is really revving much beyond 12,000rpm. This is because of the fuel flow restriction, going beyond 12,500rpm leads to a flat power curve as you have no fuel left with which to extract power (sat on the 100kg/h limit). So with no fuel flow restriction you could easily rev out to 15,000rpm but obviously by doing this you’re ultimately inviting the teams the chance at more power and therefore an increase in top speed. We’ve already noted that they are more than capable of attaining a higher top speed with the new cars than they did with the last set (09-13), and that’s whilst they’re still recovering some of the downforce they have lost. Imagine if you will once they have recovered some of the downforce they have lost, the driver will pick up the throttle earlier and this speed could be increased further.

This is partly where the battle between the teams should commence over the next few seasons as they battle over aerodynamic efficiency. I say this because I’m sure it would be relatively easy for the teams to garner some additional downforce if they wanted it, it would just come in the form of 'dirty' downforce, ie downforce that is inefficient and come at the expense of drag. The reason they are looking to create more efficient cars is that the upshot will be better fuel economy and so you can see it's a Peter, robs Paul scenario.

The other problem with no fuel flow restriction in place is the speed disparity between cars on the circuit, as the drivers still only have 100kg's of fuel onboard with which to complete the race. Imagine if you will, one driver on a concession of hot laps, pushing the envelope in order to get into the best strategy window to overtake his rival(s) at the next pitstop. Meanwhile another driver trying to save fuel because they’ve either already done too many quick laps or are saving fuel for later in the race could be 5-10 seconds a lap slower than the hot lap driver. It would be easy to see plenty of situations where a similar incident that happened to Mark Webber in Valencia 2010 could occur.

We were of course discussing the issue of the fuel flow restriction as it's the most current argument in F1 and is really a veil for the political characters in F1 to drive change that would see a narrowing of the field. Bernie, Di Montezemolo, Horner, Remi Taffin (Renault) and many
others have already alluded to the fact that in order to increase the noise made by the power units it would require more revs. To do this the fuel flow restriction must be modified or removed, however what this really masks is their intention to hand Ferrari and Renault powered teams a lifeline. Mercedes have no doubt made a better fist of every corner of their power unit when compared to Ferrari and Renault (rather than suggesting it's as simple as the split turbo concept like SkyF1 did this weekend). However where they're far superior is the way in which the MGU's work alongside the ICE to supplement power supply. If the fuel flow restriction was modified this advantage would be lost as the preference to utilise the ERS would be lessened. I will look at the differences between the 3 power unit suppliers next week but for the time being I would suggest that Mercedes have done an excellent job in understanding that the key flaw in EV technology (the batteries) can be mitigated with the transfer of energy between the two MGU's.

I explain this in my latest video but the largest challenge that faces electric vehicle technology is the storage of energy (a flaw that is plain to see in the FIA's Formula E, but this is best saved for another blog post). The reason is efficiency, with around 20% of the energy harvested, lost in the transfer from AC to DC to be stored in the ES with the loss coming at the expense of heat. However if you are able to transfer the energy directly from either MGU to power the other the loss is minimal and has more to do with voltage fluctuations. This in my opinion is where Mercedes have bested their rivals and is clear to see with how balanced the cars running Mercedes power seem when compared to the rest.
4.3 **MERCEDES W05 – SHORTEN NOSE**


Mercedes has been working on a shortened version of the nose of its F1 W05, which will be evaluated on track once it passes its crash test.

Mercedes has been running a very conventional nose, built to the letter of the law, and designed to work with the modified front wing it introduced at the start of the season. The idea behind shortening the nose is that it currently overhangs the central section of the front wing. While that is the neutral section, when you have two surfaces, one above the other, you are constraining the flow and then expanding it again, which compromises the airflow over the whole car. This is the concept behind the antetester noses, which have the cosmetic snout to satisfy the regulations but keep the start of the nose proper as far back as possible. But as Mercedes has discovered, it is a challenge to build the nose in a manner that passes the crash test.

The new design appears to have the front of the nose at the trailing edge of the central part of the front wing. This is roughly 800mm forward of the front wheel centre line, which when you include the mandatory 50mm ‘soft’ tip makes the nose as short as rules permit. The key to passing the crash test will be ensuring that debris does not get contained within the nose itself when it is crashed. If the debris can be made to disperse externally then Mercedes has a chance of getting the design through, but it will still be very difficult.
4.4 **MERCEDES REVEALS TRUE SPACE IN BAHRAIN**

[by Gary Anderson from http://www.autosport.com/f1] - [Illustrations by Giorgio Piola]

**Mercedes reveals true pace in Bahrain**

**MERCEDES DRIVERS LEWIS HAMILTON AND**

Nico Rosberg showed the true extent of the team's dominance in the final 11 laps of the Bahrain GP.

After the safety-car period, race winner Hamilton pulled out 24.067s over third-placed Sergio Perez, an average rate of 2.188s per lap. Even taking into account Perez's poor restart and disregarding the first lap of the 11-lap dash, Hamilton pulled an average of 1.966s per lap over Perez.

Key to the advantage is the strength of the Mercedes engine. During the Bahrain GP weekend, there was much talk about the advantage of its turbo design, which AUTOSPORT first analysed during the Australian Grand Prix weekend.

**GARY ANDERSON:** “Mercedes has packaged its turbo installation differently from the others. It has the hot side of the turbo at the back of the engine and the cold side at the front. These are joined by a shaft running from front to rear with the MGU-H mounted in the middle. This has several potential advantages.”

1. The heat transfer from the hot side of the turbo to the cold side is dramatically reduced, meaning that the intercooler has less work to do.
2. The pipework from the exhaust to the turbo (1 and 2) has more flexibility in its positioning, as does the pipework (7) coming from the intercooler to the airbox. Potentially, a clutch could be fitted to separate the hot side of the turbo from the cold side when the exhaust gasses are being used to generate electrical power and/or when the MGU-H is spinning up the turbo to reduce turbo lag. Either of these would help with the efficiency of the MGU-H. Chassis and engine stiffness are very important – as the engines are quite small nowadays this can be difficult.
3. This shows a machined rib going from the engine to chassis mounts and to gearbox mounts.

**4/5/6** Air ducts and coolers take up the rest of the space, each one of them individual so they can all be tuned to the correct cooling levels. The blue arrows show cold air coming in – through the cooler – while the red arrows indicate the hot air exiting.

**RACE SPEED TRAP FIGURES**

The six fastest cars through the main speed trap on the approach to Turn 1 during the Bahrain GP were all powered by Mercedes
4.5 **Red Bull RB10 – Front Wing**


Red Bull removes front-wing cascade

As Red Bull's Renault engine is down on power, the team has had to reduce rear downforce for straightline speed. That necessitates trimming the front wing for balance. In Bahrain, the team removed the forward cascade, which would normally sit in front of the main elements of the wing. The airflow coming off the back of the front wing assembly is what the car is designed to work with, but while some teams would simply reduce the front-wing angle, this will compromise that airflow. So Red Bull simply removed the whole cascade, ensuring the whole car continues to work well.
4.6 **RED BULL RB10 – REAR DIFFUSER VORTEX GENERATORS**


Few ideas in F1 racing are totally new. In the late '70's, in the heyday of ground effect, Lotus fitted small turning vanes to the lowest part of the car's floor to prevent it stalling - where an area of the car cannot flow enough air to keep the airflow attached to the surface behind it - which robs it of downforce from the underfloor. Red Bull have used the same concept on the RB10's diffuser. The small vanes on its underside (red arrow) set up a vortex, or horizontal tornado. In a normal, vertical tornado, the swirl of the air at its upper extreme is fed down to its smallest section where it meets the ground. This smaller section has enough energy to lift cars, houses or anything in its path and throw them out, sometimes miles away. Emulating this, Red Bull's horizontal tornado pulls air through an area that is suffering from potential airflow separation, giving the component that it is working on more consistent downforce.
4.7  **McLaren MP4-29 – Front Wing**


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One of the less-talked-about rule changes this year is the front wing being 150mm narrower than it was in 2014. This means that teams have to turn the airflow more aggressively to ensure it gets around the outside of the front tyres. The majority of McLaren's assembly was the same in Bahrain as it was in Malaysia except for this small vane. It is shaped the way it is because you don’t want to interfere with the airflow on the surface of the wing, instead you want to redirect the mass flow outboard and let that influence the flow on the surface to avoid suffering separation. We have seen a trend this year for teams to introduce more vertical details in their front wings as they understand more about the demands of the narrower wings having previously focused on more horizontal designs.
4.8 **MCLAREN MP4-29 – REVISED NOSE / FRONT WING**

This design, introduced in Malaysia and retained in Bahrain, has much longer front wing mounting pillars, allowing the team to use this component as a more powerful vertical turning vane to help realign the airflow that is going under the nose to the leading edge of the underfloor. This in turn will allow the underfloor to produce more downforce. Underneath the outer end of the front wing, four small vertical fins (visible here immediately behind the front wing endplate) separate the airflow in this area, dividing the wing into four sections. When the front wing gets low to the ground, part of this area stalls. The vertical fins reduce the risk of that stall influencing the performance of the rest of the wing, making for more consistent downforce - something the driver needs to give him the confidence to push the car to the limit.

[http://www.formula1.com](http://www.formula1.com) - [illustrations by Giorgio Piola]
4.9   **LOTUS E22 – BRAKE DUCTS EXTRA USE**


Modern brake ducts are largely about helping aerodynamics rather than cooling brakes. This is very much against the spirit of the regulations. In the case of the Lotus front-brake ducts, first seen in Malaysia, only one small part of them is anything to do with the brakes themselves. The red arrow indicates three small vortex generators on the top of the duct itself. Each one of these sets up a vortex that increases in size as they all get together. This vortex works a bit like an invisible vacuum cleaner to suck air from the front of the tyre and disperse it into the low-pressure area behind. This helps channel better-quality airflow between the chassis and the inside of the front tyre to the leading edge of the sidepods.

Airflow management around the tyres is hugely important given the blockage they create.
4.10 **Williams FW36 - Central Cooling Funnel**

[by Steven De Groote from http://www.f1technical.net]

Williams have enjoyed several extremely productive testing days so far, and with the end of the tests nearing, the team is applying and testing new aerodynamic parts. One of the bigger upgrades fitted on the FW36 on Thursday with Bottas and Friday with Massa is the new rear bodywork featuring wider sidepod exits and a central funnel that blows hot sidepod air around the exhaust.

The team switched bodywork throughout the day for both drivers to be able to evaluate the new parts properly. It does not appear like Williams had to add more cooling as the car ran fairly reliably before the change of bodywork, but possibly they are simply anticipating races with high ambient temperatures.

It's interesting to see how the new bodywork has wider sidepod outlets and lacks a carbon cover over the exhaust pipe. Also note how Williams' rear wing lacks a central support, instead featuring endplates that extend down onto the diffuser to provide support.
4.11 **LOTUS E22 - UNDER NOSE 'SNOWPLOUGH'**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Lotus have trialled but not raced their snowplough style appendage under the twin tusk nose since Melbourne, it did however get its first race outing in Bahrain.

5 pylons mounted centrally under the nose form a V and extrude down to the longitudinal plough element. With the twin tusk arrangement airflow still moves centrally under the nose
but as we saw with their high nose in 2012/13, Lotus still wanted to manage the airflow under the nose, with them previously utilizing the 'Pelican' underbelly. It's not all about mass flow under the nose at the end of the day, there has to be an element of quality to the airflow. The bowling pin arranged vertical pylons and plough all work to condition the flow that cascades off into the splitter region and moreover around the sidepods.
4.12 **TORO ROSSO STR9 - NEW NOSE**

[by Steven De Groote from http://www.f1technical.net]

Toro Rosso have fitted a new nose cone on their STR9 on Saturday at Bahrain, the penultimate day of testing before the Australian Grand Prix.

It was always a bit odd to see two bulges on each side of the chassis and at the front bulkhead with the detachable nose cone then featuring an entirely flat upper profile. The new design however explains why the bulges were there, as the team now have a nose that features two high arches on each side of the “finger” extension. The arches are the result of further attempts to get more air underneath the nose and as such feed more airflow under the car and through the rear diffuser.
4.13 **WORKING AROUND THE BAN ON THE STARTER MOTOR HOLE**

[by Steven De Groote from http://www.f1technical.net]

Attempting to further close loopholes in the regulations, the FIA have removed the possibility for teams to gain a substantial aerodynamic benefit from the starter motor hole in the diffuser. A first regulation change in this area was implemented back in 2010 after teams started to create unusually shaped starters, allowing them to make a larger starter hole in the diffuser, and thereby extract more performance from it. Back then, the FIA stepped in, allowing the hole to be no larger than 3500mm². Any other part of the diffuser had to be a continuous shape, a result of the earlier ban on double diffusers.

It has now become clear that further measures were taken by scrapping the starter hole completely, requiring teams to either design a flap in the diffuser that would close itself, or otherwise leave an opening that is not visible from underneath the car or further than 350mm
behind the rear wheel centre line. Clearly, most teams have gone for a flap, often metallic, as in Williams' case, enabling the starter engine to still reach the gearbox while complying with the rules in all other situations.

Mercedes on the other hand opted to create a U-shape in the centre of the diffuser. Obviously this still allows airflow through this gap and enhance the diffuser, but the effect is likely to be much less interesting than with the start holes of 2013 and before. In fact, the central starter hole was one of the main reasons why Red Bull's Adrian Newey designed tunnels underneath the RB9's exhaust ramps, as the ramps would otherwise block airflow towards the critical central part of the diffuser.

Note: even though there used to be a regulation proposal to enable F1 cars to start themselves by using the electrical energy stored in the ERS system, the rule was later dropped, requiring the use of a starter motor that brings the crankshaft up to speed before firing up the engine.
4.14 **DID MERCEDES TAKE A close LOOK AT THE RB10?**

[by Steven De Groote from http://www.f1technical.net]

Having enjoyed a reliable test Jerez, Mercedes have begun varying aerodynamic parts and verify performance, rather than only reliability. Mercedes appear to have had a very close look at Red Bull’s rear end packaging during its few outings at Jerez as the team have introduced new bodywork around the exhaust.

Until noon, the F1 W05 was seen with the same spec as in Jerez, with narrow bodywork around the central exhaust and large oval cooling outlets on each side of the gearbox. The new bodywork as in the lower part of the image shows how more air is now exited around the exhaust, allowing for a cleaner flow lower down to the floor. The solution is far away from the layout of the Red Bull (see picture next page), but the inspiration of Red Bull’s central funnel, also seen on the RB9 is obvious.
4.15  **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images in Bahrain courtesy of Sutton Images
The F1-Forecast Technical Files
http://www.f1-forecast.com
The F1-Forecast Technical Files
http://www.f1-forecast.com
The F1-Forecast Technical Files
http://www.f1-forecast.com
5. **ROUND 04/19 – CHINA**

5.1 **CHINESE GP PRESS CONFERENCE – POWER UNIT MANUFACTURERS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

The press conference from the Chinese GP featuring the power unit manufacturers, Charlie Whiting (FIA), Andy Cowell (Mercedes HPP), Rob White (Renault Sport F1), Pat Fy (Ferrari) and Yasuhisa Arai (Honda) discuss the 2014 power units.
Ferrari introduced a new front axle and brake duct assembly in Shanghai that bleeds airflow from the brake cooling duct through a duct in the centre of the axle. The idea is to direct this airflow through the axle so that it exits just behind the front tyre, into a low pressure area where the flow is coming away from the ground. When working correctly, this concept will make brake cooling much more efficient and will also reduce the overall drag of the car. However, it is by no means a new idea - Williams used it in 2013 and Red Bull currently run a similar system.
5.3 **FERRARI F14T – BLOWN FRONT AXLE**

5.4 **MERCEDES W05 - NEW NOSE**


Mercedes may have the upper hand at the moment and lead both championships, but they know their advantage won’t last forever and that they need to keep developing the F1 W05. This new nose introduced in Shanghai is shorter than the previous version (inset). It is actually the nose design around which the car was conceived, but the team struggled to get it through the FIA frontal impact test, so had to delay its introduction until now. The new design moves the most forward part of the nose rearward towards the trailing edge of the central part of the front wing (red arrows). It also allows heightens the gap between the underside of the nose and the upper wing surface. Both of these changes separate the airflow that is displaced by the wing and the airflow that is displaced by the nose. This allows more airflow through between the front wing mounting pillars, making the airflow to the leading edge of the underfloor more consistent, hence allowing the underfloor to produce more downforce.
Mercedes AMG have finally introduced their bespoke new nose cone for its F1 W05. Initially scheduled for introduction at the Australian Grand Prix, the nose cone design had to be adapted repeatedly and failed the FIA crash test three times before passing the front impact test. The team mentioned their new nose would make it easier to balance the car, admitting that the one raced so far was just a simple version while this development was ongoing. Sharing obvious similarities, the new nose cone is visible higher than before, allowing more air to flow underneath the car, aimed at increasing rear end downforce. The new design is less bulky underneath while the upper surface is more linear, arguably making the F1 W05 look better. Just like with the first iteration, the front wing supports are still fairly thick as they are an an integral part of the team’s strategy to pass the minimum section area of the nose.
5.6 **MERCEDES W05 – SHORTENS NOSE**


![Diagram of Mercedes W05 nose](image-url)

**Mercedes shortens noses**

The long-awaited new version of Mercedes's nose was raced for the first time in China. This was the design that the car was conceived with, but because it took time to get a version of the new nose that passed the crash test, Mercedes had to run the compromised 'snout' design (inset) in the first three races. The nose is shorter, and therefore a bit higher to meet the regulations. It ensures that the nose does not interfere with the airflow over the central section of the front wing. This should allow the front wing, and therefore the rest of the car, to work better aerodynamically.
5.7  **LOTUS E22 DIFFUSER VORTEX GENERATOR**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Earlier in the season I wrote about how Red Bull had used some small Vortex Generators at the transition between the reference plane / plank and the Diffuser. In Shanghai, Lotus also trialled these small appendages in the hope they could glean some additional performance from the Diffuser.

Above: A stricken E22 is returned to the pitlane and the crouching engineer assess the diffusers airflow with the assistance of the flo-viz paint. In the inset we can see that the team looked into using Vortex Generators at the Diffusers leading edge (arrowed) at another stage of the weekend.

They work by disturbing the airflow in that region which could yield results at certain speed thresholds due to the adverse angle of the diffuser. However I'd also question how they affect car balance and do they simply move the point at which peak performance is available. In previous seasons the teams have taken the opportunity to shape the starter motor hole in order
to do a similar job (injecting airflow instead) but with the starter hole now needing to be covered both Red Bull and Lotus have tried this solution instead.
The Lotus team have spent most of this season on the back foot and probably look back at last season and wonder where the performance has gone. Missing the first test didn't really do the team many favours in terms of data, but essentially they have lacked mileage throughout as they try to extract performance from both their Power unit and chassis.

The E22 is a complex car and undoubtedly has potential but the problem with complex designs is that sometimes unlocking the performance can require 5 steps backwards before you can take 1 forward. Lotus trialled a shark fin variant of their engine cover back in Australia but have since continued to run the less aero efficient but more substantial cooling variant up until China, where they raced the shark fin.

This alludes to the fact that the team are starting to get on top of some of the issues surrounding the cooling of the power unit and perhaps more importantly the turbo. The size/dimensions of the engine cover are mandated to stop the teams taking an extremely
aggressive approach to the bodywork and so the Shark Fins purpose is to meet these regulations efficiently.
5.9 **WILLIAMS FW36 - FRONT AND REAR WING EVALUATION**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Williams once again arrived in China looking to make a step forward and had several parts to evaluate, as we can see from the Wing stack above these changes included two front wings. The changes might seem outwardly small (not even visible to some at first glance) but the top flap of the lower wing is much shorter in chord at the inner section, whilst the outer section of the flap retains a little more height. After back to back testing the solutions the team opted to run the lower wing in this image.
As we can see in the upper of the two on track images Felipe Nasr filled in for Bottas and set about assessing a new rear wing top flap. The flap consists of a V in its centre which helps to bleed off some of the drag induced by the component. The team could have been testing this for future races or decided it didn't offer enough balance as the team decided to run with the none V flap for the race.
5.10 **Williams FW36 - Sidepod Shoulder Vents**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Since the season began Williams have been running the FW36 with a detached section of bodywork on the leading edge of the Sidepod (see image above). The idea being that wasted airflow entering the sidepods inlet makes its way out onto the top of the sidepods surface. This 'jet' of air uses the 'Coanda' effect to draw airflow from close by to the sidepods surface.
During the test after the Bahrain GP and briefly in China (see above) the team used a new piece of bodywork which featured a much smaller vent facing rearwards along the sidepod, doing away with how the airflow would have previously been released around the shoulder of the sidepod too. This was undoubtedly an attempt to focus the airflow over the central portion of the sidepod creating a shoulder with the bodywork instead.
It appears that the team finally decided that they would run neither of these solutions and simply blanked off the scene of the previous vent. Sidepods have essentially become an area of intense development over the last few years (chiefly because of the various forms of blown diffusers used) and almost seen as wings due to the surface area they possess and how much they condition the flow to the rear of the car. This can make them sensitive to the speed of airflow passing over them, being more efficient at one speed more so than another, this is why we see the leading edge (and just in front) of the sidepod proliferated with vortex inducing devices.
5.11 **WILLIAMS FW36 – SHARK FIN ENGINE COVER**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Williams have been using an engine cover similar to the rest of the field thus far this season with a centralised cooling outlet/funnel.

However in China the team returned to a design they used throughout 2013, which is much shorter, features a much larger cooling outlet at the base of the engine cover and utilises a Shark Fin in order to meet with the dimensional restrictions in the regulations.
The team also briefly tested a similar cover which featured gills along the fins length (picture from Felipe Massa's Instagram account above). This cover is a little different in the way the Shark Fin interacts with the rest of the engine cover (less of a bodywork void) so I'd suspect the gills help aerodynamically, to coax the airflow across the surface.
5.12 **Red Bull RB10 – Brake Ducts**


Red Bull ran modified brake ducts in China, with the inset (pictured) showing the specification it raced in Bahrain. Brake ducts are there to manage the airflow that is being dispersed by the tyre, as well as cooling the brakes. The aim is to stop the airflow going around the inside of the tyre and going underneath the car, as it loses energy working its way around the wheel. So you want to try to turn it into the low-pressure area behind the tyre. As the air hits the tyre, some is swept around the outside by the front-wing endplate, but it's the airflow around the inside that you are trying to control. The turning vanes that were on the brake ducts (inset) were about allowing that to happen, although the new version is more simple. It has to work in conjunction with Red Bull's very complex six-element front wing.
5.13 **RED BULL RB10 – TYRE SQUIRT SLOTS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Red Bull's floor in front of the rear tyre is always an area of adaption with them running the floor in very close proximity to the tyre. Inevitably the floor incurs minor damage throughout a GP weekend and requires attention, the team have 3D printers on site along with a plethora of that section of floor in order to make running repairs. You'll note that, that section of floor nearly always looks like a patchwork quilt with different variants of carbon fibre in use, depending on how much it's been returned and also how much flex they're looking for and in what direction.

Up until China the team had been utilising a similar layout to that used on the car's predecessor albeit with just the singular vertical strake rather than the two used in 2013. The principle of these slots is to shape the airflow ahead of the rear tyre and manipulate the wake as it 'squirts' laterally into the diffusers path (tyre squirt). The rigidity of this year tyres has increased significantly over last years in order to cater for the increase in torque from this year turbocharged power units and so the teams will undoubtedly make gains in this area as they understand the relationship between the tyres dynamic loads and the surrounding aero.
Above: This image is from the AMuS gallery

For China the team cut in an all new section of floor (during FP2) and continued to use it throughout the rest of the weekend. This new section of floor featured a singular boomerang slot which allows airflow to migrate underneath the floor ahead of the rear wheel. The most rearward section is convex to further enhance how the flow folds under the floor. It's also worth noting the metal section surrounding the connection point to the floor that will dictate how much rigidity the floor has as the pressure builds on the surface.
The team made a change to the front wing for the Chinese GP, likely in response to the circuit being front limited (i.e., the car having the tendency to understeer). As we can see the vane has been split into two with additional angle of attack applied, noted by the height at which the vane sits at the trailing edge of the endplate. The singular vane has been in use since the end of the second pre-season test and as I alluded to back then its job is to affect the pressure gradient outside of the Endplate, drawing the airflow inside the Endplate outward and minimising the loss of 75mm either side of the front wing this season. The slots allow some of the airflow to move between the pressure gradients forming a spiral of airflow that further aids in this attempt to draw airflow outbound.
5.15  **FORCE INDIA VJM07 – NEW REAR WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Force India took the opportunity at the post Bahrain GP in-season test to assess a new rear wing that the team adopted for the Chinese GP. It’s an all new design that features 4 core changes:

![New Old Rear Wing Comparison]

The rear wing mounting pylons have been reshaped, utilising a pear shape around the exhaust exit, similar to Ferrari and Sauber.

New rear wing endplates that feature longitudinal triangular strikes on the trailing edge, shaped upward that help to collate the pressure gradient and vorticise it, extrapolating some additional performance not only from the endplates but also the surrounding components via upwash.

The endplates also feature a new set of louvres (now horizontal) which change the way in which the airflow moves between each side of the Endplate and therefore how it affects the drag induced by the wing elements.

The rear wing also features a new main plane and top flap, with only one slot gap separator running along the centreline rather than the two equidistant ones either side of the centreline on the old configuration.
5.16 **FORCE INDIA VJM07 - SIDEPOD, AIRFLOW CONDITIONER AND FRONT OF FLOOR MODIFICATIONS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

2014’s huge rule shake up could certainly be seen by any team as an excuse to have gone a little conservative initially, especially those running the Mercedes power unit who clearly have a performance advantage over the Renault and Ferrari powered teams. Force India certainly could be seen as one of those teams, although they have a good race package haven't pushed the boundaries to the extremities as some. Having said that their deployment and installation of the power unit is admirable for a team that is often referred to as midfield.

In search of additional aero performance the team had several key modifications lined up for the post Bahrain GP test that also adorned the car in China. If we take a look at the VJM07's Sidepods we'll note that the undercut sculpting and rear section of the sidepod have seen some minor amendments, improving both internal and external flow structures that'll not only reap the rewards of better aero flow but also increase the efficiency of the power unit.
As we can see in the image above the team have also made some changes to the front of the floor and surrounding components to further maximise the sidepod changes. The sidepod airflow conditioner now arcs from a smaller bargeboard which sits slightly outbound of the main one, whilst the floor has been scrolled at the leading edge and the side scroll has been increased in height and length. These changes work to better utilise the wake dispatched by the front tyre, increasing the effect downstream giving the new diffuser the opportunity to create more downforce.
5.17 **FORCE INDIA VJM07 – REAR END DETAIL CHANGES (DIFFUSER & Y100 WINGLET)**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Force India took the opportunity at the post Bahrain GP test to assess a few new rear end details that the team then adopted for the Chinese GP.

Either side of the crash structure and within the Y100 limitations the team have been using a winglet to create upwash, at the post Bahrain test and in China this increased to two winglets either side of the crash structure (arrowed).

The team have also made alterations to the Diffuser (circled), with the largest change coming at the outer channels. The outer sections now arc over making the diffuser shorter at its periphery, with the now more complex vertical strakes still outwardly pointed in order to affect the wheels wake outbound of it. The detached Gurney trim also follows the full periphery of the diffuser rather than stopping blunt like the older specification diffuser.
5.18 **FORCE INDIA VJM07 – REAR WING TWEAKS**


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Force India makes rear-wing tweaks

Force India ran a modified rear wing in China, with some interesting detail work designed to make it work more effectively. If you look at the endplates, the louvres at the front lower edge are designed to work better with the airflow off the rear tyres. The airflow comes off the tyres and as it hits the leading edge of the endplate, unless it hits at exactly the right angle, you will get airflow separation on the inside surface. So this slotted endplate allows the airflow to attach better as it lets air through it as well. At the back of the endplate, there is also a series of little turning vanes. Because the endplate is turned outwards in order to make the wing wider than it is, the idea is to widen the wake coming off the wing to create a bigger low-pressure area. This should allow it to produce more downforce.
5.19 **TORO ROSSO VORTEX GENERATOR**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Toro Rosso had opted to start the season with a clean edge to the upper front section of the Sidepod but arrived in China with a new set of Vortex Generators.

The team have been making some alterations to the Sidepod bodywork this season, with alterations to the surface geometry of course having an aerodynamic impact. Furthermore the teams continued use of the centreline inverted Y rear wing support pylon (Y-Lon) will help to draw airflow through and over the sidepods, affecting the aero too.

If you're unfamiliar to the use of Vortex Generators their purpose is to disturb the airflow passing over the leading edge of the Sidepod, yielding a performance advantage at certain speed thresholds. The Vortex Generators added do lean over and so will invoke a slightly different aero characteristic than if they were just vertical. The height of the Vortex Generators are usually an indicator of the sort of boundary layer build up (inference: drag) that would be generated at the rear of the surface if the Vortex Generators were not used.
5.20  **THE 33.33 SECOND MISNONER**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The way I understand Formula One and try to portray its technical intricacies isn't for everyone and I wouldn't expect it to be. The sport is a multi faceted one where human endevour has to be matched by technical prowess, this is why the drivers who take the victories on the podium are quick to thank their team, be it at the track or back at the factory. What does irk me though is when technical aspects of the sport are 'dumbed down', mis-interpreted or worse of all incorrectly conveyed (whether it be from a lack of knowledge, ignorance or plain and simple mis-information.

The latest of these is the way in which ERS works and yes I know it's a complex system to talk about but if you're going to use it in commentary don't skew how it's used.

For those of you that are going 'what the hell is he talking about' it's the mis-use of 33.33 seconds of energy available for use per lap from the MGU-K. I understand where the figure has come from but using it without further context is a little frustrating and I'll explain why:

IF the energy provided by the MGU-K were still to be provided by a button press on the drivers steering wheel (a paddle for some drivers) and they had the setting on their steering wheel turned up to maximum (120kw/160bhp) they could drain all 4mj of energy stored in the ES in 33.33 seconds. Therefore we can see that the time component of 33.33 seconds is simply an extrapolation of the maximum power (120kw) vs the available energy (4mj).

Unfortunately this is where you are being misled as the time component for energy dispensed by the MGU-K is much larger than 33.33 seconds per lap (or should be). That's in part because the driver no longer presses a button on the wheel to release the energy from the batteries, but instead he will work with his engineers to map performance to the throttle pedal. This means that the full 120kw doesn't have to be dispensed all the time and can instead by graduated to match the performance of the engine, raising the kw's dispensed the more the throttle is applied. This of course makes it impossible for us to know the time component as it will be different for every driver, especially as, as with KERS before it the driver can select different maps to work alongside the engine map, reducing or increasing the amount of energy dispensed at a given rpm.

On top of this we have the supplemental energy flow that can be provided by the MGU-H and fed directly to the MGU-K, skipping out the Energy Store and therefore extending the 4mj's lifespan. This means that if the MGU-K is requesting power it can be sent from either the MGU-H directly, if it's harvesting, from the ES or both! Lest we forget that energy passed directly between the two MGU's is also more efficient as it doesn't have the losses associated with transforming AC/DC or DC/AC.
(As a side note I think it's also important to mention that the MGU-K can only recover and store 2mj's of energy per lap with the other 2mj (to take the ES's level to 4mj) recovered by the MGU-H).

I understand that it's easy to be critical and that the speed that commentary must sometimes be supplied makes it difficult to convey everything, but this generalization of how the energy is 'spent' makes a mockery of what is actually going on under the skin of these cars. This bug bear is not a new one to me as it was much the same with KERS with it often talked about as giving a 6.67 second boost. This of course was accurate if were to extrapolate the maximum 60kw/80bhp of power that could have been used and the maximum 400kj's of energy that could be used per lap. However even this was variable for the driver, usually from a rotary on the steering wheel with the driver able to reduce how much was dispensed in order to increase the time component.

I hope this post helps explain why I think it's important not to use the 33.33 seconds marker when explaining ERS.
6. ROUND 05/19 – SPAIN

6.1 THE SECRETS OF F1 FRONT WINGS

[by Craig Scarborough from http://www.autosport.com/f1]

The front wing has become the single most complex aerodynamic part of a Formula 1 car with a role that extends far beyond simply creating downforce at the front axle.

Front wings have always been a means to balance the downforce created by the rear wing. This year’s narrower front wings, down 150mm from 1800mm wide, are still more than powerful enough to match the rear end. This leaves a lot of potential that can be used for other aerodynamic purposes.

The front wing is given a tight dimensional box to sit within, while the central 500mm span is fixed by the mandatory FIA template. This makes the middle of the wing a neutral shape and one that’s unable to create downforce.

So the downforce all comes from the multi-element wing’s outer spans. These sections can have anything from three to seven elements. These are aided by one- to three-element cascade winglets sat above them. This multitude of elements allows teams to run their cars’ wings with aggressive angles of attack without stalling.

At its tips, the wing requires an endplate. Once, this was a simplistic vertical vane used to seal the low-pressure air beneath the wing from the high-pressure air above, creating downforce. Now the endplate is partly for function and partly for form, acting as a footplate, the separate vanes bonded on above to help turn the airflow.

The extra winglets mounted above the wing, known as cascades, are not to produce downforce. Instead, these are flow-control devices that, along with the endplate, perform a range of aerodynamic functions.

Firstly, the front tyres spinning openly in the airflow create a turbulent wake that creates drag. A distinctive flow structure is shed from the spinning wheel, with powerful vortices created at either side of the tyre both top and bottom.

Also, the airflow behind the tyre becomes detached and creates a low-pressure region behind the tyre.

To offset these effects, the front wing endplate and cascades direct airflow to these areas. Each of these elements sheds a powerful vortex, which counteracts the undesirable vortices naturally created by the tyres.

Further aiding the car’s aerodynamics downstream on the car, the front wing tries to send as much of its wake outboard of the front tyre as possible. Even with narrower front wings this year, there is a huge benefit to having the wing sweep airflow out around the front tyres, with an ‘outwash’ design.

Lastly, the wing sends critical airflow between the front tyres and the chassis. Where the front wing meets the neutral centre section, a carefully shaped joint will send off yet another vortex, known as the Y350 vortex because of its position 250mm from the car’s centreline.

The Y350 vortex is used to keep the front-tyre wake clear of the central bodywork on the car.
6.2 WHAT GAVE MERCEDES THE EDGE IN SPAIN?

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The all conquering Mercedes W05 continued its streak with victory at the Spanish Grand Prix, the Silver Arrows giving its drivers Lewis Hamilton and Nico Rosberg almost a second’s advantage on their closest rivals – tech guru Matthew Somerfield analyses exactly what gave them the edge in Barcelona.

Front Wing

The team with the target on their back are still pushing hard, as long as the updates they bring correlate with the data from CFD/Wind tunnel the gap to the rest will be retained. For Barcelona Mercedes arrived with a new front wing.
1. The outer Endplate canards have been reshaped, with a curvature now apparent along their width. The canards create pressure gradients midway along the endplates that help to draw the airflow from inside of the endplates outward and around the front tyre. The acute angle of the canards will also roll the pressure into vortexes, energizing the flow.

2. Added for this race another smaller canard can be found inside the endplate. This canard is much flatter and used to control how and where the pressure moves both outbound and up and over the front tyre.

3. Previous iterations of the wing have seen the slots that divide each section of the wing terminating at the arch. This wing however sees the slots extended to the endplate, these changes are inline with the canard changes above. The extra slot length is needed in order to facilitate the extra airflow that the outer canard is trying to pull around the front tyre. Without the extra slot length of each wings tier the airflow inbound (across the flaps) could be disturbed, reducing downforce and making delivery inconsistent (stall).

4. The Cascade has seen some small amendments with the inner mounting stalk reduced in thickness. This is to reduce its impact on the wing planes aft of it.

5. The lower element of the cascade is now also slightly arced at the inner point.

6. The 3rd tier of the Main plane has another slot added taking the wing to a 6 tier rather than 5.

7. The extension of the slots (3) means that the wing may flex under load more easily, this has led the team to use titanium vortex generators ahead of the rearward Strakes, increasing rigidity. This is important not only because it allows for a more consistent flow to the rearward strakes but retains the gap between the element, making it more difficult for tyre rubber to build up between them.
Sidepod Alterations

Mercedes have extended the sidepods length in order to both smooth the transition in and around the coke bottle and to dispatch of the slower moving hot air into a less crucial flow path.

Previously the hot exits terminated just ahead of the rear suspension (green) but the new exits (yellow) follow a similar design ethos to their closest rivals: Red Bull terminating much further back alongside the gearbox.

The interior airflow from the sidepod is not only hot but is less energised (having been worked, passing by all the components housed in the sidepod) and so where this airflow is released becomes crucial as it acts on the exterior airflow.
The new section of bodywork is raised and extremely sculpted allowing the maximum amount of air to still pass around the coke bottle region, further maximising the diffuser’s performance. The team have also added a horizontal blade connecting the vertical airflow conditioner (see upper inset) with the sidepod around halfway up the front corner of the sidepod, which may just help tidy up / condition the airflow as it makes its way around the sidepod’s undercut.

Analysis by Matthew Somerfield.
Subbed by AJN.
6.3 **Ferrari F14T - New Rear Wing Mounting Package**

[From http://www.formula1.com] - [Illustrations by Giorgio Piola]

For Spain, Ferrari have gone from a double rear wing pillar support (inset) to a single pillar system (main drawing), with a horseshoe mounting going around the exhaust outlet, which also becomes the mounting system for the 'monkey seat' - a small wing that is mounted on the car centre line. The single mounting pillar will mean less disturbance to the airflow going to the underside of the rear wing, while the 'monkey seat' wing will use the fairly high-speed exhaust gas to again create more downforce.
6.4 **Ferrari F14T – Front Wing Amendments**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Ferrari have started their 2014 campaign much the way they finished last season, the third best team and although Red Bull and Mercedes may have swapped places the Tifosi won't be best pleased with the scarlet outfit that promised better for this season.

In Barcelona, Ferrari arrived with plenty of new parts to assess, what they can take solace in, is the fact that the parts they bought haven't ended up back in the parts bin like those they bought to many races last season. This further proves that the correlation between what the team is seeing in CFD and the Wind Tunnel is now as it should be with parts bearing fruit when presented on the car at the circuit.

For Barcelona the team revised their Front Wing, extending the triangular slotted vane that sits atop of the Endplate, whilst the Endplate cutout was also revised, revealing more of the wings flaps. Both of these revisions are in order to better direct the airflow out, around and over the front tyre, with the team returning to a none blown hub that was installed on Alonso’s car in China to create a similar effect. You'll also note that the main planes arch (next to the endplate) has been slightly elongated allowing a little more airflow to move under the wing.
6.5 **FERRARI F14T – REAR WING SUPPORT PYLON, Y100 WINGLET & LARGER EXHAUST**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Ferrari have started their 2014 campaign much the way they finished last season, the third best team and although Red Bull and Mercedes may have swapped places the Tifosi won't be best pleased with the scarlet outfit that promised better for this season.

In Barcelona, Ferrari had arrived with plenty of new parts to assess, what they can take solace in, is the fact that the parts they bought haven't ended up back in the parts bin like those they bought to many races last season. This further proves that the correlation between what the team is seeing in CFD and the Wind Tunnel is now as it should be with parts bearing fruit when presented on the car at the circuit.

For Barcelona the team revised their Rear Wing configuration taking on board some of the design considerations seen by other teams this season, whilst still continuing to break ground themselves.
Instead of the twin rear wing support pylons previously employed by the team (above), Ferrari installed a singular centre line pylon in the inverted Y configuration (Y-Lon) as we first saw from McLaren/Marussia (below). The configuration has since been copied in one guise or another by Red Bull and Toro Rosso and now Ferrari. The inverted Y's sole purpose is not just to surround the exhaust but to act like an aspirator, using the exhaust to pull the airflow over and through the Sidepods, shaping/tailoring the inverted Y therefore is critical to each team configuration.

Attached to the inverted Y section that surrounds the exhaust we also find a Y100 Winglet / Monkey Seat reminiscent of the McLaren solution. As always the idea of this winglet is to promote the interaction of flow structures between the diffuser and rear wing flaps, creating a more unified/balanced structure. The shape of the winglet is designed to upwash the airflow being drawn through the Y section by the exhaust and upwash it.

Ferrari have gone the extra mile on how their new pylon mounts to the Rear Wing, understanding that simply mounting the pylon to the underside of the main plane can cause disturbance and separation that leads to the wing stalling (especially in Yaw). To minimise this impact Ferrari have pulled the pylon forward, to perhaps the maximum allowed position given the ban on bodywork ahead of the rear wing that prohibits systems like the F-Duct. The pylon therefore mounts on the top of the main plane adding rigidity but not drastically interfering
with the airflow, much like the swan neck style mounts used in WEC. This means that the rear wings main plane has also been changed with the main planes leading edge previously upturned to mitigate the use of the two pylons now reduced in height with the exception of the area around the central pylon.

The change of solution around the exhaust also comes with a change in size to the exhausts tailpipe, increasing it in diameter likely to match the requirements of the Y-Lon which will undoubtedly give a rise in aerodynamic performance.
6.6  **Ferrari F14T – Single Wing Pillar**

[by Gary Anderson from http://www.autosport.com/f1 - [illustrations by Giorgio Piola]

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**Ferrari switches to single wing pillar**

Ferrari started the season with a twin-pillar rear wing mounting that was bent around the exhaust (inset). In Spain, it switched to a single-pillar design. The rear wing on the Ferrari is supported by the central pillar system with the lower part of the endplate mounted to the underfloor for stability. The airflow on the underside of the leading edge of the wing travels very quickly with obstruction causing airflow separation. If this separation is severe enough, the two pillars might 'talk' to each other, making it worse. A single pillar prevents this. The single mounting pillar has an inverted 'U' lower section curving around the exhaust that extends into a monkey seat wing. All of this will make the rear wing work more efficiently.
6.7  **FERRARI'S NEW SPANISH REAR WING ASSEMBLY**

[by Steven De Groote from http://www.f1technical.net]

In an attempt to resolve its unstable rear end, Ferrari introduced a new rear wing assembly in the Spanish Grand Prix, following comparison tests during Friday's FP1 with the older twin pillar layout. On Saturday, both cars featured the displayed single pillar rear wing, a design including a curve around the exhaust pipe and a single, central pillar to provide support to the rear wing.

Ferrari previously ran two pillars with fairly long chords connecting to the bottom of the rear wing base plane. In a straight line with a head on wing there isn't much of an issue, but with crosswinds or when the car is in yaw, the pillars were blocking airflow, a particularly unwanted effect on the low pressure side of the wing as it creates turbulence where the pillars meet the horizontal plane and hence also reduced downforce. Instead, the new design has a small swan
neck attachment on the upper side of the rear wing and a much smaller chord, similar to Red Bull’s single pillar mounting.

Along with this change, the team also had new rear wing endplates with curved louvres that provide a seamless attachment to the movable flap of the rear wing. It’s a tiny change, but one that could help the flow reattach to the rear wing once the DRS flap is closed again. It’s not clear whether that was or is still an issue with the F14T, but it certainly has been at several teams in the past.

Following the Spanish Grand Prix, both drivers noted there was a notable improvement on the car, but with both struggling with oversteer, tyre wear and traction, the problems with the car are still far from over.
6.8 **MERCEDES W05 – FRONT-WING VANE**


Mercedes added a small vane (indicated by the red arrow) to its front wing. This is twinned with the pre-existing one on the outside of the endplate, which points downwards and helps to manage the airflow around the front tyre.

The curved vane inside the endplate does a similar thing, and also manages the airflow horizontally. It's all about channelling the air to where you want it around the front tyre. One of the things you are also trying to do is prevent the front tyre having a negative influence on front-wing performance, so channelling air to the low-pressure area behind the contact patch is a good way to do this.

This is an area in which we've seen development up and down the grid because this year's narrower front-wing regulations have changed the way the outboard part of the wing interacts with the tyre.
6.9 **Williams FW36 – Wing Mirrors**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Disappointingly Williams decided to change their wing mirror mounts for the Spanish GP, the stand out wing mirror design of the season saw the mirror itself mounted on twin stalks that acted as Vortex Generators for the Sidepod beyond. However with some changes made in Barcelona to their Sidepods the treatment of the airflow ahead of them is critical to how they behave aerodynamically and so a more traditional mirror stalk has been employed instead.

Of course the cockpit vanes surrounding the mirror have been retained albeit with some minor modification to their size and orientation.
6.10 **RED BULL RB10 – CHANGES FLOOR SLOT SHAPES**


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Fully-enclosed holes in the underfloor are not allowed, but you can have slots. For the Spanish GP, Red Bull introduced a more elaborate slot.

The shape of the Coke-bottle area, which is important in terms of making the rear of the car produce downforce, means that it is pulling the airflow on top of the floor surface. This in turn stops some of the air spilling into the low-pressure area under the car, which you want to avoid as it’s the low pressure under the car that creates the downforce.

Where the rear tyre meets the ground, airflow is displaced and most of this would normally be sucked under the car, reducing the potential underbody downforce. The slot helps to manage that airflow that is displaced by the rear tyre. The elaborate shape is designed to match the shape of that airflow and channel some of it outside the rear tyre.
6.11 **RED BULL RB10 - REAR FLOOR DUCT**


It's all the small details that add up to give a Formula One car so much grip. Where the rear tyres meet the ground, the air that gets displaced has a tendency to get sucked under the car by the diffuser. If that is allowed to happen, it reduces the overall amount of downforce that the underfloor can create. With this small duct (red arrow) just in front of this area, the airflow that would normally spill over the edge of the floor and go underneath the car gets redirected and some of it will go around the outside of the tyre, allowing the underfloor to work more efficiently.
6.12 **RED BULL RB10 – NEW REAR WING ENDPLATES**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Red Bull's aerodynamic superiority over the last few seasons has been driven by a few things, their use of exhaust blowing to enhance the diffusers performance, their attention to detail and the fact they're prepared to forge paths that others haven't.
For 2014 the team arrived in testing with some very basic rear wing endplates, devoid of the usual drag reducing louvres we see all the teams utilise. However once they hit the track in Melbourne it was clear they were once again looking to tread new ground, introducing endplates that featured slots behind the wing planes. In Barcelona the team have decided to return to a more conventional arrangement with louvres placed in front of the main plane / top flap. The louvres are used to reduce drag, with lower pressure from the outside of the endplate converging with the higher pressure inside, equalizing the pressure differential also reducing the tip vortices. It’s worth noting that although the team have returned to their use of the louvres they haven’t added leading edge tyre wake slots back to the Endplates.
Among the many updates, Sauber have probably introduced the most comprehensive upgrade package of the entire field in Spain with a long awaited upgrade that is set to get the car down to the minimum weight limit. Word has it that the team's update reduces the car's entire weight by around 15kg, making sure that with Gutierrez behind the wheel, the car is now no longer overweight. For Adrian Sutil however that is still far from the case as the German is approximately 10kg heavier than his Mexican counterpart.

The team have been saying their first spec was a baseline and soon admitted it was considerably overweight. The team's limited budget however did not allow for faster development. As of the Spanish GP however, the team has repackaged the cooling system, although judging from the bulge on top of the sidepod, still with vertical cooling radiators. The result are considerably smaller sidepods with cooling inlets of a reduce size.
Along with these, the aerodynamic appendages on the floor, just behind the trailing edge of the sidepod have also changed. These will help control airflow at the edge of the car's floor and underneath it, attempting to get more rear downforce. Ahead of the rear wheels, two tiny vertical panels have also been added, a feature similar to Red Bull's design on the RB9 and aimed at managing tyre squirt.
6.14 **SAUBER C33 – NEW FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Sauber season has got off to a poor start with even the team admitting they were too conservative with their initial design. For Barcelona the team have made a raft of changes that they hope will return them to challenging the rest of the midfield pack, with the reduction of around 15 kg's of weight from the chassis being perhaps the largest.

One of the key elements in the upgrade package was a new front wing, featuring a new canard/winglet attached to the outside of the endplate and a revised cascade arrangement. The principle behind these revisions is the redirection of airflow around and over the front tyre. With the regulations for 2014 reducing the overall width of the front wing by 150mm (75mm either side) it has put a further onus on the way the airflow is guided by the wing, especially as this also has an effect on the front tyres wake. Controlling the wake is critical to improving flow around the sidepods and to the performance of the floor, something that is further compounded by the loss of exhaust blowing this season.

The canard/winglet creates an area of low pressure just behind it which helps carrel the airflow inbound of the endplate to turn around the front tyre. Furthermore the new cascade is orientated outward to entice the airflow around and over the front tyre too. The wing remains relatively unchanged with the exception being the upper flaps most outbound section, which on the old wing stands slightly proud of the flap.

I must also point out that although Adrian Sutil continued to use the new front wing throughout the weekend, Esteban Gutierrez switched back to the old configuration for qualifying and the race.
Sauber season has got off to a poor start with even the team admitting they were too conservative with their initial design. For Barcelona the team have made a raft of changes that they hope will return them to challenging the rest of the midfield pack, with the reduction of around 15kg's of weight from the chassis being perhaps the largest.

Having now had the benefit of working with the Pirelli tyres for four races the teams will start to make changes to some of the aerodynamic parts that can be influenced by their wake (the stronger construction for 2014 means that the airflow behaves in a slightly different manor).

For Barcelona, Sauber installed a new set of Turning Vanes under the C33's chassis which as mentioned deals with the tyre wake when the wheels are in turned position. Their job is to re-purpose the airflow dispatched by the tyre and increase the efficiency of the airflow traveling both under the chassis and Y250 region. These new triple element vanes should complement the changes made to the C33's sidepod undercut, maximising performance.
Sauber season has got off to a poor start with even the team admitting they were too conservative with their initial design. For Barcelona the team have made a raft of changes that they hope will return them to challenging the rest of the midfield pack, with the reduction of around 15kg's of weight from the chassis being perhaps the largest.

Perhaps the largest upgrade for the C33 in Barcelona was the team change of sidepod bodywork, from inlet to outlet the profile has been amended whilst the vortex and conditioning elements surrounding it also saw revision.

Starting at the inlet you'll note that the boxy outside edge has been replaced with a much more curved surface in line with what the rest of the field sports. This of course reshapes the sidepods undercut making it essential to get the flow of air that passes around it right. To enable this we can see the team have revised the bargeboard, adding a couple of vortex generating winglets to the trailing edge of it, added an 'r' cascade winglet on the periphery of the floor and re-sculpted the airflow conditioners.
Meanwhile we can see that on the side of the cockpit some elongated fins have been added just below the mirror mount, which will further enhance the flow over the newly shaped sidepods.

The side view confirms a higher waisted undercut at the rear of the sidepod sees both the hot air from the sidepods leaving the outlets at a higher point whilst also allowing the increased flow coming around the sidepods frontal undercut to conclude in a tighter packaged coke bottle region.
Barcelona

Bahrain
Lotus continue to battle to regain ground lost having been late with their 2014 challenger, a succession of power unit issues has also curtailed the Enstone based teams performances and so they approached Barcelona with fresh vigor hoping to put some of this behind them.

Lotus briefly trialled a new front wing in Barcelona featuring outer endplate canards/winglets, as Lotus run multi element endplates each side of the wing featured two canards. The aim of these canards/winglets is to affect the pressure gradient, creating an area of low pressure behind them that helps to draw the airflow passing over the inside of the wing to move outside. This should increase the control of the airflow as it passes around and over the front tyre, which is also critical to how the rest of the car performs.
Lotus continue to battle from the back foot having been late with their 2014 challenger, a succession of power unit issues has also curtailed the Enstone based teams performances and so they approached Barcelona with fresh vigor hoping to put some of this behind them.

There has clearly been a shift of emphasis this season with the treatment of the power unit and ancillaries playing just as much a pivotal role in performance as the aerodynamic side of things. Cooling is of course just as pivotal whether it be the old V8's or the current power units and so Lotus made a mild revision to their package for Barcelona with a bulge appearing on the top of the left hand sidepod.

This has clearly been done to accommodate a size/orientation change within the sidepod and to the radiators/intercooler that is housed within. This is not balanced on the right hand side of the car but as we know asymmetry plays a role in the rest of the E22 and so they can likely offset this sharply sloping bodywork.
Lotus continue to battle from the back foot having been late with their 2014 challenger, a succession of power unit issues has also curtailed the Enstone based teams performances and so they approached Barcelona with fresh vigor hoping to put some of this behind them.

Having chosen to design their car with asymmetric features the exhaust can be offset to the right with the central rear wing support pylon offset to the left. With the team wanting to install a Y100 Winglet / Monkey Seat in Barcelona they've had to craft an extension from the support pylon for the winglet to sit on. Conversely the team have opted to centralise the Y100 Winglet, maximising it's width (200mm wide) which will unlikely get maximum upwash effect from the exhaust as other teams seem to be leveraging.

The loss of the beam wing for 2014 has however led to most of the field using winglets and structures in the Y100 region to create airflow structures that make the diffuser and rear wing interact. This therefore is a step in that direction for Lotus and will likely help the drivers with a little more balance.
6.20  **McLaren MP4-29 – Brake Duct Changes**  

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

I'm sure the McLaren team will be the first to admit that their start to the 2014 season could have gone better especially as they have the advantage of the best power unit on the grid. It's not all about the power unit though and their rival Mercedes has clearly done a better job of the catering the whole package including the aero side to the 2014 regulations.

For Barcelona the team arrived with new components to try and close the gap to the front but with a deficit of around 1-1.5 seconds to the Mercedes any upgrades they bring would need to find around 2 seconds per lap, a monumental amount of time to find.

In terms of minor adjustments, teams will make small amendments to their brake ducts at each race, by and large to affect the performance/temperature of the brakes. Occasionally though we'll see them make a step change in how they approach the winglets that adorn the brake ducts though to leverage a particular type of aerodynamic condition. For Barcelona, McLaren had amendments to the front and rear brake ducts with the front brake duct fin shaped with a much larger curve. This curve means the top section of the duct protects that section of tyre
and will therefore influence the way airflow moves around the tyre, influencing the wake too. The way in which the fin is moved away from the tyres edge lower down invites more airflow into that portion of the brake duct indicating that they're shifting their attention away from how the airflow enters one portion of the brake fairing onto another. Air flows around many pathways in a modern brake assembly due to the way all the components are faired in to reduce the negative effects of an open assembly. Pipework transports airflow around the discs, calipers and is also blown laterally out through the wheels themselves to mitigate any unwanted airflow effects as the airflow from the front wing is pushed around the front tyre. Sometimes slots are left open or covered on the 'caketin' depending on how much heat wants to be transferred via the rim to the tyres and so is hugely driver and circuit dependent.

At the rear of the car we can see that the array of winglets usually surrounding the front inner edge of the rear wheel were abandoned in Barcelona leaving only the brake scoops exposed to collate and distribute the airflow to the rear brakes.
6.21 **MCLAREN BRINGS NEW DIFFUSER TO SPAIN**

[by Steven De Groote from http://www.f1technical.net]

McLaren have fitted a brand new rear diffuser to its two MP4-29's, featuring more rounded profiles on each outer extremity, following an aerodynamic trend that was started by Red Bull Racing during the winter tests. Along the rounded edges is an additional winglet that previously used to be only as wide as the horizontal upper edge of the diffuser. The change will particularly help air extraction at each side of the diffuser, allowing for more expansion into the wake of the rear tyres.

Along with the modifications are different winglets in the rear wheel brake duct area, an update working in combination with the new diffuser.
While it may improve the car itself, the updates surely didn't bring much additional performance compared to others with Button qualifying 8th in Spain following continued complaints of a lack of downforce and grip.
There are many battles going on up and down the field in Formula One and Marussia are one such team busy making an impression on their closest rival Caterham. At one stage the battle for supremacy between the two 'new' teams had swung in Caterham's favour, having established relationships with both Renault and Red Bull that allowed them to concentrate on other areas of the cars design. However with Marussia now enjoying a technical partnership with Ferrari for their power unit and gearbox it's allowed them to express themselves on the rest of the car, focusing their efforts on delivering performance, rather than micro managing issues.

For those of you that aren't aware Marussia battled on to the very end of the V8 era utilising the Cosworth V8 only taking on KERS for their 2013 challenger (MR02) utilizing Williams technology. The problem for Marussia was they were the last Cosworth team standing, with HRT folding and Caterham moving over to Renault power it left the team shouldering the bulk of the R&D. Although minuet engine data isn't shared between teams things like off throttle blowing and the 'coanda effect' exhausts development was driven en-mass by all the teams using the same engines. I'm not saying that Cosworth simply gave up the goose but with only one team, development is always going to be a little behind the curve (unless you have wads of money to throw at something).

Marussia's use of the Ferrari products has therefore yielded advantages in terms of time spent developing mechanical components, affording them more time to concentrate on setup and aero performance.

For Barcelona the team arrived with a revised nosecone, sporting an elongated 'finger' extension that terminated under the nose. Lest we forget that although a new car is designed from the floor up, the experience garnered from its predecessor will always have an impact on how the car is laid out. Marussia therefore have tended to follow a path which dictated a lower nose and so I was initially surprised to see that the team had opted for the 'finger' extension nosecone. However in order to enable more scope and certainly the ability to get more flow to the rear of the car (read as downforce) the team took the option of running with the higher nose. The extension of the 'finger' section will of course reduce the mass flow available under the nose, but this isn't always a bad thing in all conditions. We have to remember that airflow has to be conditioned differently at different speeds and so although this option may not give peak performance it may offer better efficiency at all speeds.
Above: Both the old nose (top) and new (bottom) shows the difference between the length of the 'finger' extension
6.23  **The Decibel Debacle**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The circuit de Catalunya provided the backdrop for the second of the 2014 post race in season tests, but what was learnt? Well for starters we got the first look at the sports attempts to increase the decibel level of the new power units, which was a little disastrous to say the least. A foolhardy attempt at increasing the exhausts tailpipe was the first rudimentary attempt at increasing the noise emitted by the power units.

The FIA and Mercedes decided to trial the 'megaphone' style exhaust outlet during the post GP test in Barcelona. The 'megaphone' is simply an attempt to amplify the noise already produced by the power units, it is simply a means of extruding the pipework so the result is minimal, raising the level of noise emitted but the sound doesn't carry as far.
In reality all I can say is the noise we have is really down to the regulatory changes that were implemented. A turbocharged engine will always produce significantly less noise and be lower pitched than its naturally aspirated counterpart, for two good reasons: The turbo's job is to take the wasted energy normally dumped out of the exhaust, part of which is noise and re-energise it. This means the noise that is normally generated is dampened by the turbines impeller, using that energy (and noise). By virtue of the turbo, turbocharged cars are able to make power at much lower rpm, leading to around 6000 rpms less than with the V8's. (Lest we forget the old dogs were actually able to rev out and make more power past 18,000 rpm) This drop of
6000rpm is a major factor in the audible battle especially as gear change drop off / max performance was actually above what the new power units actually rev out to (somewhere between 11,500 to 12,500rpm dependant on team/manufacturer/map choice) making it easy to see why their shrill was much louder / higher pitched.

This latest decibel debacle is another in a long line of comedic episodes created by the sport that calls itself 'the pinnacle of motorsport'. For all intents and purposes Formula One is the pinnacle it is a breeding ground for the very best engineers, designers, drivers and one could say manufacturers. However as always Formula One finds itself arguing with how relative it wants and needs to be.

This storm in a teacup could have been avoided some time ago but instead the sport (as it always does) has left itself open to criticism, can't or won't defend itself in a technical matter and instead panders to the neigh sayers. The architecture of the current regulations was not simply dreamt up overnight and in their current guise have been largely available since circa June 2011. The brainchild of former FIA president Max Mosely the original regulations (2010) called for an even more aggressive downsizing of the ICE (Internal Combustion Engine), calling for an inline 4 cylinder 1600cc engine like you would find in most hatchbacks (at the time).

The plan to switch to inline 4's (originally earmarked for 2013) was met with objection from Bernie and Ferrari, who believed the radical change in engine architecture may well help to drive a change in the motor industry but was too far removed from the spirit of Formula One. The biggest losers in this debacle was those that had already invested time, money and R&D in the inline 4 concepts, to get ahead of the competition for the planned change in 2013. Renault, Cosworth & even P.U.R.E had actively driven resources in this direction, to steal a march on not only the current F1 suppliers (Mercedes & Ferrari) but any other manufacturers that had been enticed by these new regulations. This was real world investment that was essentially shelved, making way for another costly development in the shape of a V6 1600cc ICE. The change in ICE architecture was also met with a years delay in regulation change affording the manufacturers more time to develop the technology.

This in my opinion was the first blow in what has become a cascading change to the landscape of how the regulations are shaped. Ferrari has always held firm in its stance that Formula One needs Ferrari as much as Ferrari needs it but over recent seasons other teams have adopted this stance too. The teams now have far too much power to influence the direction in which the sport is taken and essentially meet their own needs, even if those needs are greater than the sport itself. The sport is constantly looking to be something different and that suits all parties rather than those parties conforming to the construct.

The Strategy Group is the latest in a long line of initiatives that see's the power of the sport placed in the wrong hands. The group consists of just six members (Mercedes, Red Bull, Ferrari,
Williams, McLaren and one floating member based on finishing position, currently occupied by Lotus) from the sports eleven teams giving a poor representation of what is needed in the sport to create balance. Of course one of the five other teams is represented, as Toro Rosso's say will be the same as Red Bulls. This leaves Force India, Sauber, Marussia and Caterham without a voice, as they're the teams that are probably most affected by any regulatory change due to their lack of resources compared to the other teams, I'm sure they find this an extremely bitter pill to swallow. The aim of the strategy group is to create a dialogue between the teams and the FIA, paving the way for changes to the sport. This is a slippery slope in my opinion with the regulatory body (the FIA) the only party who should be involved in the decision making process. The strategy group are making thinly veiled attempts at passing off some of their recommendations as being aimed at increasing the show for the public, however as always I'd suggest this is really an attempt at driving forward their own agendas.

Going back to the sound of Formula One and it's easy to see that the noise we have now is based on the architecture of the technology in use, any changes to improve the sound will either be frankly ridiculous (like the exhaust tested by Mercedes) or require regulatory change. The latter isn't viable, even with the PU's being re-homologated for 2015 their design is already well under way, changes now would be catastrophic. This makes life difficult for Bernie who is under pressure from the circuit owners that have contracts with Formula One and feel they aren't getting what they paid for. I do empathize with them but they too must have been naive, not able to think for themselves or have people around that are technically inept in order that they didn't understand the switch to the new power units would lower the volume. Afterall it's not like we haven't been here before and seen downsizing, furthermore this technology is new to Formula One and so I'll guarantee that there is still some movement in terms of both performance and therefore the audio, changing the sound of F1 as the teams begin to understand it (just think about the machine gun sound of 2011 when Formula One used off throttle blowing to garner more performance).

I remain ok with the sound, as I'm hearing much more of what's going on with the car, like tyres squealing under load and the plank bottoming out. However I do think FOM could do a much better job of working on the sound levels to give the broadcasters more to work with, afterall I prefer to hear the car than some of the mistakes in the commentary).
The post Barcelona GP test was of course the backdrop to Mercedes trial of the 'Megaphone' exhaust but the day before Nico donned the ludicrous exhaust appendage, Lewis tried out a new Y100 Winglet / Monkey Seat for the team.

The image in the upper left depicts the Y100 winglet that the team have been using since the start of the season. It's clear to see there are some subtle but wide sweeping changes made for the one that the team tested. The lower section of the endplates have been swept inward in an attempt to invoke the airflow in that region to be upwashed. Much like the other teams who've converged on the idea originally used by McLaren to use an exhaust surround like an aspirator, pulling the airflow both through and over the surrounding bodywork Mercedes are now looking to do much the same. In order not to drastically alter what has already been used they've opted for this more adaptive solution.
The inner curved horizontal winglets have been both shaped differently, raised to sit just under the upper winglets and covered in thermal paint (Zircotec). This is needed as you'll note that the whole winglet has been lowered at guesstimate of 20mm toward the exhaust, which also seems to have been increased slightly in diameter.

All in all the changes are a clear signal that the team are still investing time and effort in utilising and conditioning the airflow around the exhaust in an effort to extract performance, albeit with the exhaust plume generating less energy than its V8 counterpart.
6.25 **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images from Barcelona courtesy of Sutton Images.
TECHNICAL UPDATES – SPAIN – ROUND 05/19

The F1-Forecast Technical Files
http://www.f1-forecast.com
The F1-Forecast Technical Files
http://www.f1-forecast.com
7. **ROUND 06/19 – MONACO**

7.1 **MONACO MONKEY (SEAT) BUSINESS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

At higher downforce circuits you're sure to find a winglet placed in the middle of the rear wing you've often heard referred to as the Monkey Seat. Contrary to popular belief the Monkey Seat (Y100 Winglet) doesn't produce a huge amount of downforce by itself, its role is to assist in the performance of the diffuser and rear wing. That's not to say that their design is not crucial, as any airflow coming off it can aid or disturb elements like the diffuser and rear wing. It's design needs to complement its surroundings and so you'll see variation between each team, just as we do other components. (as one Monkey Seat might not work with someone else Rear Wing design). It's design depends on what the team are trying to achieve, whether it be more low speed, peak downforce or a larger window of opportunity. The array of winglets that proliferate this area can only extend 100mm either side of the cars centreline (Y100) and with the exception of the regulations pertaining to the exhaust the area is fairly free in terms of design constraints.

To create more downforce at a lower speed the team retain the rear wings usual angle of attack (AoA), but due to the upwash created by the Monkey Seat the airflow makes the wing work harder.
As we can see in the image above the at low speeds there isn't sufficient airflow for the top flap to work at its full potential, the spirals represent airflow detachment which is when the airflow separates from the wing resulting in a loss of downforce.

The use of a Y100 Winglet / Monkey Seat as pictured above can remedy the airflow inconsistencies resulting in more low speed downforce.

Of course these images are only to show you how it works and aren't directly representative of any of the teams solutions, as each approaches the solution differently depending on their current configuration and when they want peak downforce. We are of course seeing teams using Monkey Seats all the time this season, that's because they are trying to utilise the exhaust plume that is within the vicinity, increasing the net effect and mitigating the loss of the beam wing.
Mercedes W05

Mercedes arrived in Monaco with a new Y100 Winglet / Monkey Seat, designed to extract further performance, downforce and balance from the W05. Their new Monkey Seat is a further development from the one tested by the team after the Spanish GP.

Above: The team tested a new Monkey Seat at the post Spanish GP test, as we can see there are changes to the endplates (curved at their base) whilst the addition of two extra winglets above the exhaust to invoke the exhaust plume to upwash and are covered in high temperature paint.
For Monaco the team have made further revisions with the Monkey Seat featuring much taller endplates and an additional horizontal winglet placed at the top of it which help to control how the airflow upwashes and interacts with the rear wing (without this the upwash may be too steep and interact with the rear wing too early).

This season the teams are using the centreline exhaust in conjunction with the Monkey Seat in order to extract more downforce, it's a design principle that McLaren followed from the start of their campaign and many have assimilated. The idea is that the exhaust plumes low pressure high energy flow pulls the airflow through or past any bodywork that's placed within it's proximity. (In the case of McLaren their Venturi shaped pylon support which surrounds the exhaust) Mercedes have designed their new endplates with a curvature at the bottom of them in order to condition and isolate the flow to do similar, this is important as they've now
extended their sidepod outlets to exit inline with the main central cooling outlet (amended for the Spanish GP).

The additional winglets added above the exhaust that the team tested at Barcelona have been covered in high temperature paint (likely Zircotec) as these will invariably get hot due to their continuous interaction with the exhaust plume.

All of these changes were made in order to create flow structures that allow the diffuser and rear wing to work in unison and create more low speed downforce.

Red Bull RB10
The chase for downforce is still on for the team that everyone else believes to have the most in hand, with the team adding a new upper winglet to complement the lower one the team have been using so far this season. Having decided to run a Y100 winglet under the exhaust and just below where the old beam wing used to run the team were/are clearly looking to enhance the way in which the diffuser interacts with the exhaust.

The introduction of the higher Y100 winglet which sits astride their regular one looks to create further interaction with the underside of the rear wing, whilst undoubtedly utilising the exhaust plume as it exits below it.

Lotus

Having added a Monkey Seat at the Spanish GP the team revised its design for Monaco, introducing a secondary tier. The two winglet approach is used to discern extra upwash, with the slot between the two winglets helping the upper one overcome the more extreme angle of attack of the upper winglet.
Toro Rosso converged on McLaren's singular mounting pylon (Y-Lon) as few races ago with the intention of using the cylindrical section that wraps around the exhaust to pull airflow through and over the Sidepods (amendments were made to these too, in order to exploit this). Continuing along the same path as McLaren the team arrived in Monaco with a new Monkey Seat which hung off the rear of the cylindrical exhaust cover. The double tier winglet looks to exploiting the airflow in this region, creating up wash that would help both the Diffuser and Rear Wing work more effectively together.
You'll note however that Toro Rosso's design features endplates on each of the winglets, these are usually used to increase the aspect ratio of the winglets and further condition the airflow.
Sauber

The Swiss team had a plethora of updates for the C33 in Spain, not all of which can be seen as successful with the team still struggling. Monaco provides a vast difference in terms of aero balance when compared to Barcelona and so the team ploughed on with the same parts, trying to further understand where they'd gone wrong.

Like all of the teams mentioned above Sauber decided to run with a Monkey Seat for Monaco, which although they were chasing performance I'm quite sure it would have offered the drivers a little more balance too.
7.2 **VIDEO - ANATOMY OF THE 2014 POWER UNIT**


For the 2014 season, Formula One racing has adopted new turbocharged 1.6-litre hybrid power units. In this video we explain the key components and how they work together.
Despite their dominance, Mercedes keep developing their car in the hope of keeping their advantage for as long as possible. For Monaco they had a new front-wing endplate. The detail change at the rear (1) is to optimise the airflow going around the outside of the front tyre. The front wing by regulation is 75mm narrower per side than last year and this detail will help try to connect the airflow in this area to the low-pressure area just behind the front tyre where it comes away from the ground. The new turning vane (2) works in conjunction with this endplate change. If this low pressure behind the tyre and the exit of the endplate can be made to 'talk' to each other then it will make the endplate work much more efficiently. The outer section of the front wing's main plane (3) has also been altered, with the inboard blend of the raised section having more of an edge. This is to reduce transverse airflow, which if allowed to happen can cause airflow separation on this section of the wing, reducing the downforce potential of this component.
7.4 **MERCEDES W05- 'MONKEY SEAT'**


One of the noticeable differences to Mercedes' F1 W05 Hybrid in Monaco was the addition of a 'monkey seat' above the exhaust outlet. This small wing section not only produces extra downforce, its performance is enhanced because the exhaust gasses that pass over it are traveling at a higher speed than the car itself. This is especially beneficial when the car is going through a low-speed corner and the engine revs are high. This is because the more rear downforce you can generate in these situations, the better traction you have exiting slow corners. Nowhere is this of more critical importance than Monaco.
7.5  **MERCEDES W05 – NEW FRONT WING ENDPARTS**

7.6 **MERCEDES & RED BULL LOOK TO MONKEY SEATS**


Mercedes and Red Bull look to monkey seats to increase exhaust downforce

Monaco is all about finding downforce. Downforce helps to raise tyre temperatures and, at low speed, also helps to increase traction off the slow corners. A monkey seat at the rear of the car increases downforce by helping the exhaust gases to pull air over its winglets. Whenever the car is moving slowly — as happens more often around Monaco — exhaust gases reach relatively high speeds because of the high engine revs, and this helps the monkey seat to generate even more downforce.

For Monaco, Mercedes (above left) added a horizontal plane above their main two-element monkey seat that sits beneath the rear wing. The top section has been added to stop the monkey seat affecting the upper wing, which for Monaco is set at the largest depth the regulations allow.

Red Bull (above right) also looked to a monkey seat to increase low-speed downforce. The car previously had a monkey seat underneath the exhaust pipe, but the team introduced one above it as well for Monaco. This change is likely to be Monaco-specific.

This year's restrictive aerodynamic regulations over the rest of the car, and the resulting loss of rear downforce, mean that this is one of the main areas of aerodynamic development, along with the nose and front wing endplate.
7.7 **Red Bull RB10 - 'Monkey Seat'**


Monaco is a track where you want as much downforce as possible. The tight and twisty track layout and very slippery surface mean that it is very difficult to get temperature into the tyres. As an example, tyres running at something like 60 degrees Celsius as opposed to 80 degrees can cost a driver up to a second in lap time. Downforce helps generate tyre temperature and with that in mind Red Bull have added what is called a 'monkey seat' to their rear wing set-up. This is a small wing just above the exhaust outlet, which works in conjunction with the higher speed exhaust gasses in this area. These allow it to produce more downforce, especially at low car speeds when the engine revs are high, generating more high-speed exhaust flow.
7.8 **RED BULL RB10 - NEW TURNING VANES, CAMERA MOUNTING**


For Monaco, Red Bull have altered the turning vane that is mounted on the bottom of the chassis, underneath the driver's feet. Normally this is a two-piece component - as shown in the main drawing - which is very similar to a vertically mounted two-element wing. Now (inset) they have the lower section of it blending into a one-piece component. Changes like this are small, but they all add up to give that little bit more overall downforce which will improve lap time. As a reference, on a normal type of circuit, at 240km/h with no drag, an extra 12kg of downforce is worth about 0.1 seconds per lap. In a separate development, Red Bull were asked to move the onboard cameras on the front of their car in Monaco. The team had found a small loophole in the regulations that allowed them to mount the forward-facing cameras inside the 'vanity panel' which smooths the nose-to-chassis intersection (avoiding a stepped-nose appearance). However, with the camera mounted in this position - looking through a small hole - it was not possible to get any footage worth showing on TV. They have now mounted the cameras externally in a similar fashion to Mercedes and Ferrari.
As we can see from the image above Lotus arrived in Monaco with a new set of rear wing endplates, featuring slots in the leading edge. These slots help to distribute pressure from the outside of the endplate inbound, making it more efficient. (You’ll also note that the thickness of the endplate around the slots on the leading edge has been reduced). These tyre wake slots have featured on other cars since 2012 with some teams now utilising 2 per endplate but this is the first time that Lotus have ventured into this territory.
7.10 **LOTUS E22 - FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

As I reported after the Spanish GP, the team had tested a new front wing during that weekend but didn't run it for qualifying or the race. The team did however bring and run the wing in Monaco and what wasn't clearly visible from the shots available in Spain was that the new outbound endplate cascades have slots in them, just as we find on the ones used by McLaren.
7.11 **FERRARI F14T - COOLING CHANGES**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Ferrari revised their sidepod profiles between the Spanish GP and Monaco, making amendments that change the aerodynamic characteristics of the car (deeper undercut at the rear of the sidepod) but also the way in which the internal airflow is dealt with. These changes are in response to the new rear wing support pylon (Y-Lon) and the way this interacts with the exhaust and surrounding bodywork.

As we can see above the cooling outlet through which the exhaust exits is much smaller than the one used in Monaco (below). The curved element that surrounds the exhaust works with it to create a low pressure zone that pulls other airflow from surrounding bodywork through, making the area more efficient, creating more upwash. The upshot of course is that Ferrari will now be making changes in this area to maximise performance with the changes for Monaco likely the first step in a series of amendments over the next few races.
UPDATE: As @LuisFe F1 has just rightly pointed out to me, both Fernando and Kimi ran the larger cooling exit in Spain. I had, had a mix up in my image galleries as Kimi ran the smaller cover for FP3 not Qualifying as I thought he had. (we all make mistakes). This means the cooling/cover changes were made in line with the new Y-Lon in Spain for both drivers.
7.12  **RED BULL RB10 - COOLING FUNNEL CHANGE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

I've already alluded to the changes that Red Bull made to their Y100 Winglet / Monkey Seat but the team also revised their cooling outlet to accommodate the aerodynamic appendage, narrowing the funnel. This change will not only have an effect on the cooling of the car but also the aerodynamics too.
7.13 **INSIDE THE MIND OF F1’S BATTERIES AND ELECTRONICS**

[by Craig Scarborough from http://www.autosport.com/f1]
With this year’s increase in ERS power, the design of control electronics systems and energy stores in the engines is critical.

The Energy Store (ES) is the battery. This stores energy harvested by both the kinetic (ERS-K) and heat (ERS-H) energy-recovery systems for reuse. Within the ES enclosure is a large array of lithium-ion cells. To package the dozens of cells inside the enclosure, either cylindrical or pouch-type cells can be used.

Aside from housing the cells, the energy store also has electronics to manage the condition of the individual cells. Hundreds of cell parameters are monitored, including temperatures, voltage and current. Cells can be taken out of use if they are failing, but not every manufacturer has this functionality in their energy store.

With the ES storing its energy in a DC electrical format and the MGUs on the engine using three-phase AC power, there needs to be an electrical conversion between the two systems. This is achieved with the control electronics (CE).

Typically, there is one control unit for both the ERS-K and ERS-H. When harvesting energy, the MGU will send its AC power via three high-current cables to the control unit.

Inside, a series of high-current switches called IGBT (Insulated Gate Bipolar Transistors) take the power and pass it through capacitors to convert it to DC format. From here the DC power is sent via two cables to the ES. Sending power from the ES to the MGU is the reverse of this method. These electronic units also provide the car with its 12-24V supply for the usual electronics, ignition and fuel injection.

The packaging of these two control units varies among engine manufacturers and teams. They can be either packaged within the ES enclosure or separately in the sidepods. Being separate provides more design freedom, but is heavier due to the cable and cooling pipework.

The inversion process from AC to DC and back again creates losses in the form of heat. The charging and discharging in the cells in the ES creates heat, so both systems need cooling. Typically, this is done with a dedicated water-cooling circuit, requiring a reasonably sized radiator in the sidepod.

Although cooling is critical, in order to run at maximum efficiency the batteries need to run within a narrow operating temperature. This is hotter than ambient temperature, so pre-warming of the water inside the cooling circuits is required.

Equally, the batteries prefer to work with a specific state of charge (SOC). This is the amount of energy the batteries hold at any specific point. SOC needs to be maintained within a tight operating window. The battery can be pre-charged before a session, but not during it. The ES can also be rapidly brought up to a good SOC on the out-lap or early laps of a session.
7.14 **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images from the Monaco GP courtesy of Sutton Images.
Aerodynamic & Mechanical Updates 2014 – Volume 2

TECHNICAL UPDATES – MONACO – ROUND 06/19

The F1-Forecast Technical Files
http://www.f1-forecast.com
The F1-Forecast Technical Files
http://www.f1-forecast.com
8. **ROUND 07/19 – CANADA**

8.1 **VIDEO - BRAKE-BY-WIRE EXPLAINED**


Formula One cars have used electronic 'fly-by-wire' throttle technology for years, but this season the sport has also adopted electronically-controlled rear brake systems for the first time. But just what is brake-by-wire and how does it work? This video guides you through the technology. For more information, you can also check out our brake-by-wire feature.
8.2 **VIDEO – FERRARI F1 ENGINE 2014 OVERVIEW**

[by Craig Scarborough from The Racer’s Edge]
8.3 **VIDEO – WHY MERCEDES STRUCK TROUBLE IN CANADA**

[by Craig Scarborough from *The Racer’s Edge*]
8.4 ** VIDEO – F1 AERO UPDATE WITH CRAIG SCARBOROUGH**

[by Craig Scarborough from The Racer’s Edge]
8.5 **SECRET OF F1’S STOPPING POWER**

[by Craig Scarborough from http://www.autosport.com/f1]

Brake performance will be key at this weekend’s Canadian Grand Prix, but remains an unsung technical aspect of an F1 car.

As downforce has increased, the potential grip from the tyres can be exploited for greater braking without fear of locking up. Reduced braking distances are not, as many believe, directly thanks to carbon brake discs. An F1 car’s brakes are similar to those of a road car. The pedal acts on master cylinders, which pressurise the fluid to operate the pistons in the caliper. The caliper presses brake pads against a disc to provide the friction for retardation. But in an F1 car, the calipers use six pistons to press carbon fibre pads against a machined carbon fibre ventilated disc.

Brake discs and pads are made from the same specification carbon composite and can withstand enormous temperatures. The disc weighs around 700g and by regulation must be a maximum of 278mm in diameter. Disc thickness is also limited to a maximum of 28mm.

The disc/pads can withstand temperatures up to 1200°C. At these higher temperatures, the disc will start to oxidise and wear excessively, leading to eventual failure. Conversely, carbon brakes do not work as effectively at temperatures below 300°C. Discs and pads wear at the same rate, but modern braking materials mean wear is just 1mm if cooled effectively.

In order to get the right ‘feel’ drivers will have a preference for brake-disc supplier and material, while different circuits will require different drillings inside the disc. Drillings can vary from a simple line of 24 holes to complex slots or multiple small-diameter openings. Teams may also drill the back of the pads to help reduce heat transfer into the calipers.

Discs are mounted to the axles via a titanium bell. The disc is bolted to the outer rim of the bell and the inner opening of the bell fits via machined splines to the axle.

Working the pads against the discs, are the calipers. Regulations allow just one caliper per wheel, with a maximum of six pistons working on two brake pads. As calipers are more efficient if they are stiffer, further rules limit the stiffness of the material used (80 gigapascals, or GPa) and only allow two bolts to mount the caliper to the upright. Each caliper is machined specifically for each team and the calipers are not interchangeable; front to rear, left to right or between teams.

Calipers are machined in one piece from a solid billet of aluminium alloy. With stiffness being traded against weight, the caliper only has material where it’s needed and everywhere else is machined away.

Inside the caliper, two sets of three titanium pistons push the pad against the disc. Heat from the disc and pad need to escape to keep the entire braking assembly cool so the back of the caliper is machined out to allow airflow to escape. Brake ducts now also route cooling air to the pistons.
8.6 **FERRARI F14T - MONTREAL ENGINE COVER**


In an effort to improve the efficiency of their overall package, Ferrari tested a much tighter-fitting engine cover in Montreal, featuring longer sidepods and - as can be seen in the main drawing - extending further at the rear of the car, finishing inside the rear tyres. The main function of the new configuration was to help the overall cooling, although that came at the cost of downforce. It would therefore only have been of use in Montreal and Monza, due to the higher average speeds of the two tracks. Ferrari, however, decided the package didn't offer enough benefit in terms of cooling, and reverted back to their original configuration (inset).
8.7 **FERRARI F14T - TRIAL REVISED BODYWORK**

[by Steven De Groote from http://www.f1technical.net]

Ferrari have introduced a considerable upgrade package for their F14T in Montreal, including a new floor and this more apparent new bodywork. Fernando Alonso was seen on track with the new bodywork layout while at the same time Kimi Raikkonen ran with the older configuration, allowing the team to do immediate comparisons in the pitlane and back in Maranello.

The update includes the removal of the air outlet around the exhaust, allowing for sleeker upper bodywork. The tradeoff are slightly larger outlets across the suspension arms, which interestingly extend further back as well, similar to Red Bull's layout and following the change that Mercedes did in Spain as well. Along with the modifications is a different sidepod panel as well with in particular a modified horizontal element.
The problem for Ferrari though is that they have considerable difficulty in determining what works on the car and what doesn't. On Friday evening, Alonso already mentioned that of all the new aerodynamic parts introduced, only the new floor is a certain improvement. This, combined with the knowledge of higher ambient temperatures on Sunday's race, the team opted not to race the new bodywork, instead aiming for another go at the next race.

Also interesting is that Ferrari are back at using their twin pillar rear wing. Both Ferrari's raced with a single pillar mounting and an additional monkey seat in Spain and Monaco but have opted for the old layout again at Montreal.
8.8 **FERRARI F14T – LOW DOWNFORCE ENGINE COVER**


“In an effort to improve the efficiency of its car, Ferrari introduced a much tighter-fitting engine cover for the Canadian GP. It fits around the exhaust outlet and longer sidepods that now come further rearward and inside the rear tyre. Previously, these outlets were used to help the overall cooling, but you get nothing for nothing and when you have something that makes the cooling better you pay a price in downforce. This didn't offer sufficient cooling, and Ferrari reverted to its conventional sidepods.”
8.9 **Williams FW36 - Montreal Brakes**


Montreal is the most difficult circuit on the calendar for brakes. Five big stops per lap mean that brake cooling is a major headache for all the teams. Everything is a compromise on an F1 car - use more airflow for brake cooling and you lose downforce, so it is all about getting the balance correct. Over the past few years developments in materials technology have meant that the carbon brake discs and pads will withstand more heat than before and in Canada they can see temperatures in excess of 1000 degrees Celsius. If you see excess black brake dust coming from the wheels, that is the discs and pads wearing and a sign that the car could be running into trouble. On the Williams there is a duct (top blue arrow) that goes over the top of the disc to take some of the air that is going into the main brake duct (blue arrows on the right) over to the outside of the brake calliper (small dotted blue arrows show path of airflow). It is very important to cool the calliper or else the hydraulic fluid inside the calliper will boil. If that happens the brake pedal will have excess travel and a very spongy feeling, which around Montreal - with speeds in excess of 330 km/h - is the very last thing you want.
8.10 **MCLAREN MP4-29 - MODIFIED REAR SUSPENSION BLOCKERS**


In Montreal practice McLaren tried out using just one (red arrow) of their rear suspension 'blockers', as opposed to the usual two (inset). These blockers, which are in fact bodied rear suspension elements, increase the performance of the diffuser and replace some of the downforce lost with the removal of the lower rear beam wing for 2014. However, they come with quite a high drag penalty. Perhaps not surprisingly, McLaren reverted back to the normal twin blocker set-up for qualifying and the race. When a car's aerodynamic working envelope is defined, the car and the components to achieve this envelope are all optimised and work together - removing any one of these components will change the car's characteristics and it will be very difficult to find something short term that is more efficient to replace it.
8.11 **MERCEDES W05 - SUSPENSION UPDATES**

On top of their Montreal-specific upgrades, Mercedes introduced a couple of small changes to the front suspensions? lower front wishbone and the rear section of the front brake ducts. The new fins and turning vanes help to manage the airflow coming around the inside of the front tyre. Getting this airflow to connect with the low-pressure area behind the front tyre will reduce the overall drag of the car, and also help the front wing to perform more efficiently.
8.12 MERCEDES ERS ISSUES

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The silver arrows dominance so far this season hadn’t faltered but just as many were starting to dream of a whitewash, the team suffered a technical gremlin on both cars that scuppered their chances of victory.

Both Mercedes cars scampered away from the grid in usual fashion, leaving the rest of the field trailing in their wake. What looked like an unassailable lead suddenly became a battle for survival as both W05’s incurred the same technical issues on lap 36 for Lewis and lap 37 for Nico. Both cars suffered a high voltage control electronics failure, curtailing performance by virtue of the MGU-K unable to propel the car.

Control Electronics (CE) have been one of the biggest issues thus far for the engine manufacturers and teams with drivers likely to pick up grid penalties all over the place in the latter part of the season. The CE is actually made up of several different components but replacement of any of these blots the copy book. Sebastian Vettel and Kamui Kobayashi are the most likely candidates to take the first grid penalties owing to CE changes with these drivers already accruing the use of 5 components. As soon as they use their 6th it will be a 5 place grid penalty for that race, something that I personally find harsh based on the infancy of this technology in a Formula One environment. The other components that can receive penalties (ICE, Turbo, MGU-K, MGU-H and Energy Store) are complex items but don’t perhaps undergo...
the same rigors as the CE which binds the aforementioned components. Perhaps it would have been shrewd of the FIA to allow 10 CE component changes in the first season?

Lewis/Mercedes made a change to the CE-KCK on his W05 before qualifying for the GP but as yet we don’t have confirmation which part of the CE failed on both W05’s. What we do know however is that both cars had no ability to deploy (EDIT after confirmation from Mercedes) or harvest energy from the MGU-K for the rest of the race. (Mercedes have stipulated that the MGU-K was unable to provide ‘drive’).

The question therefore no longer remains on how much the MGU-K was still able to do in terms of harvesting, it’s clear that initially both drivers were getting little to no assistance from the MGU-K under braking and is the likely result for Lewis’ rear brake failure. (Owing to the teams running smaller rear brakes this year, with the MGU-K doing a proportion of the braking as it harvests power).

Brake-By-Wire (BBW) is also a factor in this as the system proportions off the amount of bias front to rear based on the current amount of energy being harvested, the sudden loss of the MGU-K would have unsettled the BBW putting the onus back onto the cars standard mechanical braking system. With the smaller brake components in use this season and the driver unable to react in short time by adjusting the balance forward, the rear brakes begin to overheat. This unfortunately bought Lewis' race to an untimely demise, Nico was fortunate enough to have another lap under his belt before the failure, giving the team the time to react with instructions similar to those already given to Lewis.

The movement of brake bias forward would have undoubtedly led to a disparity in how both Mercedes drivers were able to stop the vehicle in the corners. Aided by the lead to the rest of the field though, a lift and coast into the corners would not only allow for some fuel saving (critical with the loss of top end performance as more fuel would be needed) but also aid in braking stability.

The complexity of the energy recovery system on top of the turbo charged engine this season means that there are many modes with which the driver has in his armory. The loss of power from the MGU-K however is a massive loss as not only does it provide upto 160bhp (120kw) at the top end, the power is gradually applied alongside the throttle inputs, increasing the amount of time that the MGU-K provides power (upto 4mj or 33.33 seconds at full power) (Please read this if you don’t understand how the MGU-K can utilise the 4mj). The loss of energy deployment by the MGU-K can be covered up in part by pushing the ICE to do more work but inevitably this increases the fuel flow and it cannot make up the entire deficit.

Driving around and adapting to the lack of MGU-K power or harvesting won’t have been easy for Nico and the mere fact he was able to lap at a relative pace to some of the cars chasing him is a
testament to the job Mercedes have done this season. It also shows us that the MGU-K is providing at least 2 seconds of performance per lap this season.

NOTE: The issues suffered by Perez were BBW related with a similar situation regarding the loss of the rear brakes that Lewis suffered occurring on the VJM07. This in turn causes confusion within the BBW system that is trying to react to changing levels of brake bias/force.
8.13  **CATERHAM CT05 - LOUvre-LESS REAR WING ENDPLATES**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Caterham arrived in Canada with a new set of rear wing endplates, both drivers tested them during the free practice sessions but only Kamui raced them (Ericsson switching back to louvred endplates due to his crash in qualifying).

Teams use louvres in the endplates for efficiency with pressure moving from one side of the endplate to the other, which in turn reduces the pressure gradient where the flaps meet with the endplates. This pressure gradient entwines into a vortex (which we often see in the form of vapour trails, in damp conditions). By allowing the pressure to move from one side to the other side of the endplate this vortex is more controlled reducing the drag induced by the flaps. You’ll often see the shape, orientation and number of louvres adjusted based on the circuit characteristics and corresponding wing angle of attack.

I’d therefore suggest that Caterham were looking to gain more downforce/balance for the low speed corners but sacrifice a percentage of their top speed around the Circuit Gilles Villeneuve, although it must be said that Caterham do run very long leading edge slots when compared with the other teams and so they may have found this offsets some of the louvre loss.
McLaren's season hasn't got off to the sort of start they would have liked and have once again made several intrinsic design decisions that have perhaps hindered their development curve. One layout problem invariably leads to several others but one of their decisions which was supposed to boost performance was their 'wishbone wing' rear suspension. Embodying the wishbones in much larger fairings looked to bridge the performance gap lost by the beam wing this season, however other items had to be designed around it too and so rather than just changing one items invariably you end up with a list of items.

Don't get me wrong it wasn't a bad idea but as other teams have shown there is still the opportunity to create downforce even without the beam wing or structures placed in a similar locale. In order to place use the wishbone wings and give them as much freestream airflow as possible the team opted to place their cooling ducts higher up, either side of the exhaust outlet. We have since found out that Mercedes HPP made a late call (just before pre-season testing) on the exhaust manifold to be used by the Mercedes powered teams, whilst both Force India and Williams have re-sculpted and changed rear end cooling options McLaren have not.
McLaren's design was clearly more reliant on the older specification exhaust with far more space now inside the sidepods, which will have a detrimental effect on the thermal/aerodynamics. Making swift changes of this magnitude are not easy, especially as the layout of radiators etc also determine both airflow characteristics and bodywork shaping.

Moving back to Montreal and both drivers tried their MP4-29 with no upper 'wishbone wings' during Free Practice (See main image above) in order to try and reduce some of the drag induced by the components. However the team returned to the usual configuration for qualifying and the race most likely owing to a better performing car/strategy for the race.
8.15  **LOTUS E22 - REAR WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The Enstone based squad still seem unable to fully unlock the potential of the E22, a complex car that clearly isn't being helped by the Renault power unit struggles.

For Canada the team arrived with a new rear wing, complete with a low downforce configuration main plane and top flap (shallow AoA), whilst the endplate louvres were reduced to two. The team returned to their pre-monaco monkey seat/Y100 winglet initially trying to run without but finding the car lacked balance in the low speed corners.
The configuration of Circuit Gilles Villeneuve puts an onus on both good straight line speed (low drag) but also good braking stability and mechanical grip, owing to the long straights and low speed turns. The team therefore bought a new rear wing (above) to try and garner some extra straight line speed, the main plane featuring a raised central profile that arcs outward toward the endplates, whilst the upper flap also has two V's cut along its top edge to further reduce drag.
Sutil (above) continued to persevere with the draggier specification wing whilst Gutierrez chased the performance from the lower downforce/drag setup although interestingly his FP3 crash came at a point when he had the higher downforce wing on the car.
8.17 **RED BULL RB10 – LOW-DRAG REAR WING TWEAK**


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To attempt to compensate for a lack of horsepower, Red Bull ran a smaller-section rear wing in Canada. Traditionally, it has focused on corner speed and lived with a straightline deficit, but because of the level of the Renault engine it has had to take a different approach.

Compared with the Mercedes Montreal rear wing, the Red Bull version had a much smaller section. But the package is only for Montreal. It made the car a bit more difficult to drive; it would have been good on fresh rubber, but with the car sliding around more it also accelerated the degradation.

During Friday practice Red Bull also ran with a slot gap on the leading edge of the rear-wing endplates to allow the airflow being spilled around the front of the rear wing to re-attach to the inside of the endplate. But it did not run with the vertical slot after that.
8.18  **MERCEDES W05 – FRONT-END REVISIONS**


As well as some Montreal-specific components, Mercedes also introduced several small changes at the front of the car. The team made small modifications to the lower front wishbone and the rear part of the front brake duct.

Both of these fins/turning vanes are there to manage the airflow coming around the inside of the front tyre. Managing this airflow and getting it to connect to the low-pressure area behind the front tyre will reduce the overall drag of the car and help the front wing work more efficiently.

With brake cooling in Montreal very important, Mercedes, like Williams, ran a brake cooling package featuring a duct going over the top of the disc to feed air to the outside of the calliper. This is to keep the fluid inside the calliper away from its boiling point.
8.19  **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images from the Canadian GP courtesy of Sutton Images.

McLaren MP4-29 Front Wing, note the new Johnnie Walker logo
Lotus E22 - Front Wing detail, note the outboard pressure gradient vanes that were tested in Spain and run at Monaco
Caterham CT05 - New Louvre-less Rear Wing Endplates
Williams FW36 central rear end detail
Caterham CT05 Front Wing detail
Marussia MR03 under chassis turning vane detail (3 tier)
Force India VJM07 - Rear Wing endplate detail (note the new sponsorship livery)
Williams FW36 - Rear End detail
Williams FW36 - Detail, note the cooling apertures on the side of the airbox and their close proximity to the FOM cameras
Red Bull - Storing a steering wheel and Front Wing cascades
Red Bull RB10 - Front Brake duct assembly
Mercedes W05 Rear End/Floor detail (note the rear brake fins)
Mercedes W05 Front Wing detail
Caterham CT05 - Still carrying both Front Wing iterations to GP's
McLaren MP4-29 Front Wing detail, note the outwardly curved strakes
McLaren MP4-29 Floor detail, note the two tier section which allows airflow to move inbound/outbound to cool PU components
McLaren MP4-29 Front Wing detail, note the section in the main plane that allows for ballast to be changed
Mercedes W05 - Front Wing detail
McLaren MP4-29 Rear end detail
McLaren MP4-29 detail including Bargeboard and Sidepod Airflow Conditioner
Williams FW36 under nose and front wing detail
Red Bull RB10 Front brake assembly detail
Ferrari F14T - Great shot of the new engine cover and elongated sidepods treated in flo-viz to ascertain if they're performing as expected
Ferrari F14T - Great shot of the new engine cover and elongated sidepods treated in flo-viz to ascertain if they're performing as expected
Ferrari F14T - Great shot of the new engine cover and elongated sidepods treated in flo-viz to ascertain if they're performing as expected
Red Bull RB10 - To suit the medium downforce characteristics of Montreal the team aren't running the nose with it's usual 'pelican' underbelly, whilst at the rear of the car the team have reduced the number of endplate louvres but re-introduced leading edge tyre wake slots (not used since last season)
Aerodynamic & Mechanical Updates 2014 – Volume 2

TECHNICAL UPDATES – CANADA – ROUND 07/19

The F1-Forecast Technical Files
http://www.f1-forecast.com
Ferrari F14T - Note the height of the upper flap, the team have cut the top element down, removing not only the gurney trim but also the V grooves (use the image above this as a reference)
Mercedes W05 - New heat treatment added to the top of the crash structure and more added to the Monkey Seat since Monaco.
McLaren MP4-29 - The team trying the car without the upper wishone 'wings' almost certainly in an effort to reduce some drag.
McLaren MP4-29 - Pitot tube array placed ahead of the rear wheels to assess the airflow in the region, most likely as a result of only running the lower wishbone 'wings' as mentioned above.
Ferrari F14T - 'Back to Back' testing for correlation the older specification engine cover and sidepods
Force India VJM07 - Flo-viz applied to the rear wing to assess the sections cut off the top of the top flap (see lower image for comparison with regular flap)
Lotus E22 - Lower downforce rear wing (much shallower AoA)
Aerodynamic & Mechanical Updates 2014 – Volume 2

TECHNICAL UPDATES – CANADA – ROUND 07/19

The F1-Forecast Technical Files
http://www.f1-forecast.com
Ferrari F14T - Top/rear view shows that the sidepods have been extended to reach beyond the rear suspension elements now.
9. **ROUND 08/19 – AUSTRIA**

9.1 **Analysis: What Happened with Renault in Austria?**

[by Steven De Groote from http://www.f1technical.net]

The Austrian Grand Prix turned out to be an extremely difficult one for all Renault powered runners, bringing to light more public frustration from Red Bull Racing’s team principal Christian Horner. But is there really a problem with the Renault engine?

It's particularly interesting to observe that at a fairly similar power track that is Circuit Gilles Villeneuve, it was exactly Red Bull Racing that took the top step of the podium. There, Daniel Ricciardo seemingly had no trouble finding pace and clearly confirmed the trend that Red Bull Racing was becoming the best team behind the Mercedes works team.

Renault introduced several new parts in Canada albeit most of them aimed at improving reliability, introducing software and improvements to their diagnostics to prevent issues like the MGU-H and exhaust failures that happened in Monaco. They were well needed, knowing that Montreal was the toughest challenge on the engines so far this season. The company also mentioned that energy recovery from the MGU-K is limited at Montreal, hence focusing on the MGU-H to recover energy through the exhaust gases.

Arriving in Austria, teams had much less accurate simulation data following a string of 11 years without an Austrian GP on the calendar. The track near Spielberg is however known to be power sensitive with around 50% full throttle on a lap. The small number of corners again made it difficult to get a lot of energy recovery under braking, hence also requiring engine suppliers to focus on the MGU-H to charge the batteries.
Even despite all these similarities, all Renault runners had considerable trouble keeping up with the Mercedes cars and were also comfortably beaten by Alonso, the fastest of the Ferrari powered cars in Austria.

**BUT IS IT DOWN TO RENAULT?**

It is, but it's unlikely to be the only reason. Focusing on power, it's good to have a look at the top speeds at the end of each sector, showing clearly that the Mercedes runners had an advantage - as well as in Canada.

Averaging the top speeds of the two fastest cars for each engine supplier, we get the following result (in km/h).

<table>
<thead>
<tr>
<th>Engine</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercedes AMG</td>
<td>320</td>
<td>229</td>
<td>284</td>
<td>325</td>
</tr>
<tr>
<td>Ferrari</td>
<td>308</td>
<td>226</td>
<td>277</td>
<td>318</td>
</tr>
<tr>
<td>Renault</td>
<td>308</td>
<td>226</td>
<td>276</td>
<td>318</td>
</tr>
</tbody>
</table>

Note that S1 is the point on the straight between turns 1 and 2, just before braking for turn 2. S2 lies halfway between turns 5 and 6, a slower section of the track emphasizing grip and aerodynamic downforce. S3 is obviously the finish line. T is the speed at the speed trap, located just ahead of braking for turn 3, recorded during qualifying.

It's immediately obvious that Ferrari and Renault are very closely matched when it comes to top speeds while Mercedes is quite a bit ahead. At S1, the difference is around 3.7% and at the speed trap 2.2%.

**SO WHAT WAS SO DIFFERENT IN AUSTRIA THAT MADE RENAULT STRUGGLE MORE?**

The first important difference to consider between Canada and Austria is the nature and the number of the corners. The Montreal circuit features several medium quick chicanes, allowing Red Bull to make use of its apparently strong chassis and aerodynamic properties to stay ahead of the pack. Spielberg, in contrast is notorious for being less of an aerodynamic differentiator and instead puts an even stronger emphasis on traction out of slow corners. This obviously plays into the hand of stronger drivetrains.
Secondly, both Renault and Mercedes have said that MGU-K energy recovery at Spielberg is more limited than in Canada. With such limitation, we can assume that each power has the potential to regenerate a similar amount of energy from braking during a lap around the Red Bull Ring. Needless to say, the difference in potential power - depending on the exact power unit mapping - then comes from either the internal combustion engine, its turbo, or the efficiency of the MGU-H.

Clearly, the turbo is playing a considerable role here, especially because Spielberg is about 700m higher above sea level than Montreal. This means that, while the engine itself does not really suffer, the turbo spins at a much higher rate to compensate for the low ambient pressure – very close to the hardware limit.

Whatever the truth, and surely the engine developers have figured it out for a long time already, the Austrian Grand Prix may well have exposed the weakness of Ferrari and especially Renault in that their turbochargers may be less conveniently sized than the ever so dominant Mercedes power unit. Sadly for them, if hardware really is the issue, there’s little to do but to start investigating how to have a better unit next year, as changing to a different turbocharger only for performance reasons is not allowed during a running season.
Williams produced a shock in Austria as they proved to be the most competitive team after Mercedes, carrying the fight to the championship leaders throughout the weekend. One of the secrets behind their pace also came to light over the Spielberg weekend - an innovative intercooler installation previously thought to be unique to the Silver Arrows (Click here for more). It was revealed earlier this season that Mercedes' decision to place the turbo and compressor at opposite ends of their power unit (Click here for more) has made cooling far more straightforward, and it's now emerged that the Mercedes-powered Williams squad have - like their engine suppliers - used this fact to cleverly locate their intercooler immediately behind the cockpit (red arrow). This allows them to run smaller, more aerodynamic sidepods, with incredibly neatly packaged radiators - a design arguably second only to Mercedes' own in terms of efficiency. Rivals using Ferrari and Renault power have not been able to integrate this layout since their power units group the turbo and compressor together at the rear of the engine (Click here for more), but expect it to become a trend on all teams' 2015 cars.
9.3 **F1’s Newest Form of Energy Recovery**

[by Craig Scarborough from http://www.autosport.com/f1](http://www.autosport.com/f1)

This year, Formula 1 adopted a new kind of energy-recovery system on top of the kinetic (ERS-K). There is now the ERS-H, the H standing for Heat. This is a second motor-generator unit (MGU-H) alongside the turbocharger shaft.

The heat title is a misnomer, as the MGU-H harvests the kinetic energy of the rapidly spinning turbocharger, not its thermal energy. Unlike the ERS-K, the energy recovered, stored and reused by the ERS-H is not capped and can add to the capped energy limit of 4MJ for the ERS-K.

To recover energy, the MGU-H works in its generator mode to create electricity within its internal windings. When the driver is off the throttle, the spinning turbocharger is slowed by the magnetic drag of the MGU-H. The energy collected can then be reused.

This energy can be either stored in the batteries for use later or immediately deployed. In either case, there are two ways that the energy can be used, either to spin the turbocharger back up to reduce turbo lag or to power the larger MGU-K extending the 33-second duration of the 160hp ERS-K boost.
In the former case, the energy is sent via the three-phase AC cables to the control electronics and then into the battery. As the driver presses the throttle pedal to accelerate, the energy flow is reversed and the MGU-H is used as a motor to spin the turbocharger. As the turbo is spun up quicker, more boost is immediately created for a quicker response and more acceleration.

In this mode the ERS-H acts like a wastegate on the turbocharger, although wastegates are also fitted to the exhausts to reduce turbo lag or overboost in some situations.

In the second mode, the ERS-H can add directly to the power at the rear wheels. Energy created by the MGU-H can be sent via the control electronics to the MGU-K.

Energy from ERS-H in this mode can be either from the battery or direct from the MGU-H. In the latter case power can even be harvested on full throttle. However this is effectively burning fuel to create the energy, so this mode is only used tactically, such as in qualifying or for overtaking during the race.

The unit is similar in size to last year’s KERS MGU, being somewhat larger than a road car’s alternator. As the MGU needs to have a mechanical link to the turbo, the unit is typically coupled to the turbocharger’s shaft. Renault mounts its MGU in the ‘V’ of the engine, this being in front of the turbocharger, which is at the back of the engine. Mercedes, with its split turbo design also mounts the MGU in the engine’s ‘V’, but the unit sits on a long shaft between elements of the turbocharger.

Ferrari also has the MGU mounted between the compressor and turbine; uniquely this is on a much shorter shaft, and sits with the turbo behind the engine. These different positions have little effect on the MGU-H itself, but are more to do with the packaging of the turbo and its cooling.
9.4 **MERCEDES W05 - HARNESSING MERC’S HORSES**

[by Craig Scarborough from http://www.autosport.com/f1](http://www.autosport.com/f1)

One of the key design aspects of the Mercedes F1 W05 HYBRID is the integration of the new-generation power unit into the chassis. This is a benefit both in terms of power delivery and the aerodynamic packaging of the car. It’s perhaps too simplistic to say that the close relationship between the Mercedes F1 base in Brackley and Mercedes-Benz High Performance Powertrains in Brixworth is solely responsible for this. After all, Ferrari’s chassis and power-unit departments are together in Maranello, while Renault has a very close relationship with Red Bull.

Yet Mercedes has ended up with an engine that sits well in the chassis and still produces not only excellent peak performance but a smooth power delivery. Several facets of the power-unit design typify the inter-departmental thinking that has boosted the W05’s performance in the turbo layout, exhaust system, and charge air cooling.
ENGINE PACKAGING

The turbo layout has been the focus of a lot of media attention, with the two major components of the turbo — the compressor and the turbine — split between the front and rear of the engine.

Mercedes has mounted the compressor stage at the front of the engine and the turbine at the rear. These are joined by an elongated shaft that also spins the MGU-H as part of the energy-recovery system (ERS).

This immediately takes the heat-transfer problem of the hot turbine away from the compressor, being relatively cool now that the compressor is shrouded by the engine oil tank — something that’s not practical with a more closely coupled turbo. Having a cooler charge means more power can be produced. Also, the intercooler and hence the sidepods can also be smaller for better aerodynamics.

Next, the pipework that feeds the air compressed by the turbo back into the engine can be much shorter. This reduces turbo lag and therefore aids driveability of the engine.

A less obvious benefit for similar reasons to the turbo position is the exhaust system. This is unique in the current crop of the new power units, as it uses a ‘log’ layout, rather than longer separate pipes. With this design, the exhaust gases exit the ports in the cylinder head via very short pipes, which immediately join a larger common pipe, which then routes directly to the turbo. The benefits of conventional exhaust tuning are lost in place of greater exhaust velocity at the turbocharger.

The net result is more power from the turbocharger rather than gas exchange in the cylinder head. A side benefit is that this set-up is incredibly compact, which is critical for the aerodynamic shape of the Coke-bottle area of the sidepods. Again, power and aero are the winners from a single design decision.

Both these features are common to all Mercedes-engined cars — so McLaren, Williams and Force India all benefit from these designs.

One area where Mercedes has diverged from its similarly engined rivals is in the way it cools the air compressed by the turbo. Rather than a bulky air-to-air intercooler, Mercedes has adopted the water-to-air solution.

Packaging this, Mercedes uniquely positions the smaller water-jacketed intercooler in a recess in the back of the fuel-tank area, leaving a much smaller water radiator in the sidepod. This aids driveability as again the pipe routing is so short, and aerodynamics are improved as the sidepods can be much smaller. Although this solution comes at the cost of weight, if a lighter chassis can offset the extra mass of the cooler then performance will benefit overall.

POWER DELIVERY

When describing a power advantage for an F1 motor, it’s often peak horsepower that is the focus. But it has long been realised that driveability can be far more important in cutting lap times.

This is one area where Mercedes is far superior to its rivals. The design of the power-unit packaging sets out to reduce turbo lag and boost driveability. Also, the efficiency of the ERS means that electrical power can be used to smooth the delivery of power as the car accelerates. Having a better power delivery is also critical for tyre management and Pirelli has noted that Mercedes has the lowest rear-tyre slip on the grid.

Any spikes or variances in power delivery under acceleration create wheelspin. This added energy going into the tyre will prematurely wear the tyres and lose the car performance over a stint in the race.

Compounding the benefit of driveability is driver confidence — having the car snap into power oversteer may look exciting to TV fans, but wins no favours from the timing screens.

The more predictable and progressive the power delivery can be, the easier it is for the driver to manage the car, not only when he’s at 100 per cent on a qualifying lap, but also when he needs to be consistent in the race.
COOLER PACKAGING

Gary Anderson: This shows the superb integration of the intercooler/cooler packaging (left) and the engine. It’s an area where Mercedes has a clear advantage over its customer teams because there is a lot to gain.

1 Intercooler
2 Water radiator
3 Intake for turbo
4 Oil tank
5 Engine-stiffening brace
6-8 Ducts for the gearbox and hydraulic cooler
9 The exhaust pipe connects to the hot side of the turbo
10 Exhaust

SPLIT TURBO

Gary Anderson: This is a logical design. You’ve got hot air coming out of the exhaust into the pipework, so the turbo side that is affected by the exhaust can be running at up to 600°C. And if you’ve got another element attached to the side made of aluminium, while you’ll try to insulate it, some of the heat will transfer.

Mercedes has the inlet side of the turbo at the front of the engine (in blue), and the shaft going through the V (red dotted line) to the exhaust half of the turbo (red) at the back of the engine. So these two parts – one of which you want as cool as possible and one you want as hot as possible – have been separated.

There’s nothing you can look at in the Mercedes engine and declare a revolution. This design is important, but it’s not the case that you simply take this approach and have the best engine. It’s one of the many good ideas in the Mercedes package.
**FRONT WING ELEMENTS**

*Gary Anderson:* Like Red Bull, Mercedes has recently chosen to go down the path of running a large number of elements (up to seven) in its front wing. While this does offer less peak downforce than having fewer slot gaps, it makes the airflow much more consistent. If you do get airflow separation, it will be over a far smaller proportion of the wing.

The red arrow indicates a vane added at the Spanish GP designed to better manage the airflow around the front tyre. It's an indication of the kind of small detail work the team is able to focus on after getting its initial concept correct.

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**SHORT NOSE**

*Gary Anderson:* At the Chinese Grand Prix, the Mercedes raced for the first time with the shorter nose design. As the graphics show, in order to meet the regulations, the shorter nose (top drawing) finishes slightly higher in its revised form.

The car was conceived around this design, but it took a lot of effort to produce the nose so that it was able to pass the frontal crush test and did not appear until the post-Bahrain GP test. The original nose hung over the neutral section of the front wing, and when you have two surfaces one above the other, you are constraining the airflow and then expanding it again. This can have a negative effect on the car as a whole.

The antaeae noses have a cosmetic section to satisfy the regulations with the nose itself not starting until further back. The W05 has a different solution to this. The front of the nose is at the trailing edge of the central part of the front wing, roughly 800mm forward of the front-wheel centreline. It will have taken a lot of work, as you need to ensure debris is not constrained when the nose is crushed, as this will increase the force of the impact.

The result is a nose that should supply better airflow to the rest of the car. It's also testament to the quality of the engineering at Mercedes.
FRIC SUSPENSION ALLOWS GREATER CONTROL AND RAKE ANGLE

Craig Scarborough: Looking at the chassis in isolation from the power unit, the complex interlinked suspension system known internally as FRIC (Front Rear Inter Connected) continues to be an asset for the team. Now mature technology, the Mercedes system remains one of the more complicated, with the hydraulic links working not only to control pitch, but also roll and a combination of the two modes. The system still requires a mechanical spring and anti-roll bar to provide the base spring effect for the suspension. The passive hydraulic cylinders on each corner of the car’s suspension are linked with pipework through an accumulator and valve system. These can then be used to tune the suspension’s reaction to heave, dive and roll, which allow greater control over the aerodynamic underbody and better prevent the splitter against grounding. More rake can be run for even better aero performance.
9.5 **Ferrari F14T - Engine Cover Cooling**


One of the biggest areas of development we have seen this season is with cooling, and the various locations for cooling exit ducts. Airflow that is used to cool the various components on the car is airflow that cannot be used to create downforce, so the more efficient the cooling package the more downforce the car will produce - and the more grip it will have. Ferrari have an interesting cooling solution. Along the spine of their engine cover they have an opening which can be completely open (fairly inefficient), or have a louvred panel fitted (medium efficiency), or be completely blocked off (most efficient). Which setting to use depends on the conditions - from blocked off in cooler conditions to fully open in hot conditions.
9.6 **FERRARI F14T - SIDEPOD AND REAR WING AMENDMENTS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Ferrari’s 2014 challenger has once again failed to live up to the expectations of both the team and their fans. Not only is it a handful to drive but making aerodynamic changes has proven to be a difficult task. The team have faltered in their adoption of the new rear wing package first introduced in Barcelona, with the team switching back and forth between the two packages and begs the question, have they solved their Wind Tunnel issues? There appears to be a negligible performance difference between the two packages and so one can only assume the newer option still has potential that as yet remains untapped OR the large scale difference that was present in CFD and the Wind Tunnel just doesn’t appear when at track. Austria proved no different than the last few races with the team back-to-backing for correlation purposes during Free Practice sessions.

The team chose to run the newer configuration albeit with a few minor tweaks, the Y-Lon receiving a small lip at its trailing edge designed to influence the exhaust plume, rather than the team using the full Y100 winglet (Monkey Seat) as they have before. Whilst the cooling outlets
were once again slightly revised with the outlets running along the spine of the engine cover blanked off.
Having made a small change to their airflow conditioners shoulder for Montreal the team arrived in Austria with another configuration (lower image). This time focused on the width of the conditioners with the new ones sporting a wider base than its predecessor. The idea is to stop the airflow that makes its way around the sidepods undercut spilling over the floors edge, whilst minimizing the impact the tyres wake has on this flow structure.
9.7  **FERRARI F14T - COOLING**


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**Ferrari’s open-and-shut cooling case**

> With this year’s complex engine packages, featuring more powerful hybrid technology, there are extra cooling demands.

There’s more energy in the battery pack, with more heat generated, so that makes a big difference.

Ferrari is still experimenting with its cooling set-up, meaning that it tried running with open bodywork during Friday practice before switching to a closed version for the race. Closed would be the most efficient aerodynamically, followed by the open version with the louvres (as pictured). Fully open would be the worst. For cooling performance, it is the other way round.

It’s very easy when working on a car in the wind tunnel to neglect the cooling demands, which is why it’s always best to start with a conservative cooling package and then close it up rather than risking compromising your package for more cooling.

Ferrari’s experiments suggest that, even though it could run closed, there are still cooling issues.
9.8 **MCLAREN INTRODUCES SHAPELY NEW FRONT WING**

[by Steven De Groote from http://www.f1technical.net]

As part of a fairly large aerodynamic update for its MP4-29, McLaren have introduce a long overdue front wing update, getting rid of the rather bulky previous design that looked dated in comparison to items seen on front running cars.

The new front wing only appears to have the leading edge of the base plane and parts of the endplates in common with its predecessor, but other than that everything is new. Still a three-element wing, the insides of the flaps have considerably changed, featuring an increased opening in between the second and third element.

At the inner edges of the flaps, minor profile changes are now more pronounced, designed as such to impact airflow downstream, rather than being aimed at local downforce generation.
Also marked are the new stacked elements, now smaller but flanked by a standing panel similar to what can be seen on the Mercedes AMG F1W05. This acts to direct airflow outboard while generating a counter clockwise rotating vortex onto the inside of the front wheels. Hence it is no surprise that McLaren's update also included minor updates to the brake ducts as well as a different profile of the floor left and right of the car.
In Austria McLaren took the unusual step of exposing their rear brake disc to the wheel rim. This is typically done to channel some of the heat generated by the brakes into warming up the tyres. There is a balance to be struck to avoid overheating the brakes, and while exposing the disc is usually an effective solution at the front of the car it is normally less so at the rear, where heat can be generated more simply by a touch of wheel spin. Indeed the two ends of the car require different philosophies. At the front, teams will look to direct airflow into the brake duct, through the disc and then have it exit through the outside of the wheel. At the rear, in contrast, teams still want to take air into the brake duct (red arrow), but then want it to exit on the inside of the wheel in order to reduce drag.
McLaren had plenty of new parts to try out at the Red Bull Ring but one that didn't cut the mustard and the team didn't race are the Turning Vanes, the brilliant Giorgio Piola caught a picture of them above (Source: omnicorse.it).

The under chassis vanes help to condition the airflow that moves under the nose and chassis, whilst protecting it from the wake created by the front tyres (especially in yaw). The new vanes have a similar rearward section to those that have already been in use, whilst the most forward element (which is attached to the underside of the nosecone rather than the chassis) was elongated. This section you'll note also has an elongated slot in it but doesn't go as far as making it a full blown additional section.
McLaren bad start to the season has been clear to see, I've discussed before how several key design decisions made when designing the car have been pivotal in this years car performance, meaning bouncing back this season will be difficult at best. However for Austria and Great Britain the team have a raft of parts to try and rectify some of their deficiencies.

An area that was criticized by many last season was the MP4-28's front wing. Pivotal as we know because it shapes the air as it flows over the rest of the car. The team made some changes that bought them relatively inline with the rest of the field toward the end of last season. They were also the first to utilise the outer Endplate gradient winglets this season (Mercedes & Lotus have also followed suit since) but their wing in general still feels a little basic when compared with the front runners.

The changes made this weekend were to the cascade winglet, making it much narrower again (the team ran a narrow element early in the season) and adding an 'r' cascade in bound of this.
Both are changes designed to intensify the way in which the wing pushes airflow up and around the front tyre.

Changes were also made to the upper flaps, rolling the inner tips which will have an effect on how the Y250 vortex is generated.

It's far from me to say their front wing doesn't work or is worse than others, however it's development speaks volumes of the theirs and others predicament this season. Development this season has been deliberately curtailed by the FIA in order to help cut costs, with reductions to CFD and wind tunnel work. The teams have of course been given the opportunity to test after some of the races this season but without the time available to evaluate parts before generating full scale parts this seems a little contrived. Making up ground, has therefore become more difficult and as such the ebb and flow that follows the sport begins again with the top teams re-investing in areas that will bring them gains.
9.12 **McLaren MP4-29 - Front Wing Upgrade**

[by Gary Anderson from http://www.autosport.com/f1]

McLaren’s new front wing is a shift in philosophy, aimed not just at maximising front downforce but making the whole car work. The slot gaps and details at the end of the slots will channel the airflow around the front wheels, or inside them, and under the floor to maximise downforce. The step in the mainplane creates the vortex around the sidepods and also improves the performance of the underfloor. Further outboard, downforce has been added to the front end. The outboard ends, just inside the endplates, ensure the wing is consistent whatever the angle of the front wheels. There are some detail shortcomings. The front-wing adjusters don’t fall in line with the airflow, which will interfere with performance slightly.

McLaren has been doing the same thing for a long time – maybe too long. I use the words of Ron [Dennis], who said it became an engineering team rather than a racing team.

McLaren racing director Eric Boullier says there has been a “culture change” at the team since his arrival.
9.13 **McLaren MP4-29 - Rear End Changes**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

McLaren's bad start to the season has been clear to see, I've discussed before how several key design decisions made when designing the car have been pivotal in this year's car performance, meaning bouncing back this season will be difficult at best. However for Austria and Great Britain the team have a raft of parts to try and rectify some of their deficiencies.

McLaren's MP4-29 has several large concepts built into its design with their 'Wishbone Wings' (covers that shroud the suspension elements) being one of them. Over the last few races the team have trialled the car without both the upper and lower covers and/or just the bottom ones during Free Practice sessions but reverted to their use for the race.

For Austria the team revised some other areas in order to run without the upper shrouds for the race. That's the problem with a design that's inexplicably linked to the aero structures at the rear of the car, when you remove or redesign it, it has a compound effect on other components.
In Austria the team made a revision to the perforated gurney trim, cutting it much shorter. Taking a leaf from the Red Bull book (although Red Bull themselves haven't fully committed to their use all the time) the team also added some small Vortex Generators at the diffusers leading edge, designed to make the transition between the planks flat bottom and diffusers incline less overwhelming. This will ideally make the diffuser work over a wider operating window and therefore give the driver a little more balance.
9.14 **McLaren Backtracks on Suspension Blockers**

[by Steven De Groote from http://www.f1technical.net]

Along with its brand new front wing, brake duct modifications and floor edge updates, McLaren changed the configuration of the rear of its MP4-29 in Austria. A new diffuser was part of the car’s aerodynamic upgrade package, featuring different curves at the outer extremities, allowing for a little more expansion in the diffuser. The winglet sloping around the edge of the diffuser has now been cut back, making it a very similar configuration to the diffuser that the team ran in the races before the Spanish GP.

McLaren have also, for the first time this season, raced its cars with blockers only attached on the lower track rods, making for 2 blockers contrary to 4 and thus virtually cutting their butterfly suspension in half. The team experimented with this layout in free practice in Canada but went on to race with the fully blocking suspension arms. This likely means that McLaren have finally found some additional rear downforce, making the upper and highly draggy blockers unneeded. It will be interesting to see if McLaren retains this layout for the next races, and even if or when they will decide to drop the lower blockers as well.

Finally, also marked in the image are a number of paired, converging strakes added in the central part of the diffuser. Each pair will create two counter rotating vortices, energising the air in this area of the diffuser. This particular design is more or less copy paste from Red Bull Racing, and so we may expect to see them appear on more cars as the season progresses.
9.15 **NEW SIDEPODS JUST THE BEGINNING FOR TORO ROSSO**

[by Steven De Groote from http://www.f1technical.net]

Toro Rosso have introduced new sidepods on their STR9, removing the curvature on top of the sidepod in favour of a new, more gradual slope towards the rear suspension. Looking from the back of the car it is obvious what the team have tried to achieve as the hot air exits are now closer to the floor, converging towards a design used by Red Bull and Mercedes AMG. In fact, more and more teams are going this direction as Force India had a similar sidepod update, leaving McLaren to be the only team left with outlets alongside the exhaust pipe.

The move may also have allowed the team to relocate some sidepod internals further down to lower the car's centre of gravity, but thus far the team have not confirmed this.
Also note that the monkey seat above the exhaust pipe as seen in Austria is nothing new and featured on the car at Monaco as well. It seems it was only dropped for Canada due to that circuit's lower downforce requirements.

Despite this looking like a big update, the team's Technical Director James Key noted handily that the updates are a start of a series with more to come at Silverstone and Hockenheim.
9.16 **TORO ROSSO - NEW FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

The sister Red Bull team arrived at the companies circuit in Austria looking to improve performance with a new front wing. The original DNA remains but several key changes have been made to affect how the wing performs. Teams are of course still gaining performance based on the reduction of the Front Wings width in 2014 (down to 1650mm from 1800mm, or 75mm either side), which of course affects how the airflow is turned around the front wheels.

The team latest iteration (bottom) sees the main cascades increased significantly in width, with the inner most section, outwardly angled. This along with the addition of another outwardly
angled vertical fin placed in the centre of the cascade, looks to push the airflow, up and around the front tyre. This is not only essential to the performance of the Front Wing but will also have an effect further down the car, as the tyres wake begins to impact the floor. Being able to control the way in which the air flows around the front tyre also leads to more control further downstream.

The team have also changed tact when it comes to the design of their flaps, with the older specification sporting a top flap that was only split a short way along its length. However the new wing features a twin top flap arrangement allowing the wing a wider operating window before flow starts to separate. This splitting of the upper flap allows differing angles of attack to be initially set, giving the team license to change the flaps height, camber, chord and/or orientation.
9.17 **TORO ROSSO STR9 - NEW FRONT WING**

Toro Rosso introduced a new front wing in Austria, as part of a much larger upgrade package including a new underfloor and rear wing assembly. As the front wing is the first part of the car to disrupt the airflow it can have serious effects on how the rest of the car works downstream. This new assembly is more sympathetic to the airflow that goes inside the front tyre which means the airflow going to the leading edge of the car's underfloor has more energy left in it. This in turn allows the diffuser to work more aggressively, creating more underbody downforce. The new wing (inset) has a smaller upper forward wing and a more pronounced vertical turning vane, along with some detail changes on the flaps. In itself the revised wing is not really a big development. However, it allows the rest of the car to perform better, as witnessed by the team's pace in Spielberg.
9.18 **TORO ROSSO STR9 - FRONT WING ALTERATIONS**


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When you want to change downforce levels from circuit to circuit, you want to do it in a way that does not disturb the wing, so ideally you don’t want to modify the angle of the flaps.

Toro Rosso has a new, more stable front wing that should improve the whole of the car.

The previous, three-element forward upper wing remains but inside that was a two-element package that has now been removed. Anything you mount inboard of the turning vane affects the airflow inside the front tyre. Ideally you want to minimise that interruption.

The flap detail is aimed at getting better airflow between the front wheels. Note the shape of the front-wing adjuster, which follows the direction of the airflow. It's a nice detail.

This is part of a larger Toro Rosso package, which includes a new rear wing and diffuser, that has been in the pipeline since the start of the season.
9.19 **TORO ROSSO STR9 - SIDEPOD CHANGES**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Seen as the Red Bull B team and frankly well under budget compared to the A team, Toro Rosso are really starting to punch above their weight. Clearly the FIA's stranglehold on the CFD and Wind Tunnel regulations should suit some of the midfield pack and Toro Rosso are seemingly taking advantage of that fact.
As part of a pretty large upgrade package the Faenza based squad made what outwardly looks like a minor change to their Sidepod cooling outlets. In fact it changes not only the way airflow is dealt with internally but also changes the Sidepods upper surface performance, whilst providing a cleaner airflow path around the coke bottle and another low pressure zone above the diffuser. Austria proved to be a bad race for the team but expect these changes to have a good affect going forward.
Sahara Force India introduced a considerably aerodynamic upgrade for its VJM07 at Austria, including several front wing tweaks. As indicated in the image comparison, the front wing endplates now have one additional separate turning vane in an attempt to get more airflow outboard of the front wheels. The underside of the endplates have also slightly changed, dropping an edgy curve in favour or a nicely rounded profile.

Interestingly, the team have also opted to move the attachment points of the front wing forward, requiring a modification of the front wing pillars. It’s no secret that the pillars are important to manage airflow underneath the nose, but in this case it looks like the mounting points have been redesigned for additional stability of the front wing. The wing is fixed by two titanium screws on each pillar, and imagery has shown the screws are now farther away from...
the other as well, reducing the possibility for the wing to rotate - albeit marginally - under load. Contrary to what it may look like, the team did not modify the nose cone and only the pillars were redesigned to connect to the front wing about 5cm more forward.

Note that the team also added a winglet above the front wheel brake ducts, most likely to create a vortex that will influence airflow onto and around the sidepod further downstream.
9.21 **FORCE INDIA VJM07 - SINGLE REAR WING SUPPORT PYLON**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

For a brief period during Friday's free practice sessions Nico Hulkenberg ran his VJM07 with a new rear wing support, instead of employing two pylons as the team usually do (below) they trialled the car with just one. It's unclear if the pylon was mounted through the engine cover like Red Bull does or whether they employed a Y-Lon but I'm sure we'll see this used again in Silverstone. The pylons of course increase rigidity to the wing but will have an effect on the aero too, with this in mind teams have been making alterations to their setup since the start of the season to make gains.
9.22 **FORCE INDIA VJM07 - NEW FRONT WING MOUNTING / NOSE**


Force India have introduced a new front wing mounting (upper drawing) for Austria, with a more curved leading edge to the wing pillars. This means the connection to the front wing is over a larger area, which will create a stiffer wing mounting. The nose itself appears to be slightly different on the leading edge where the top surface rolls around into the lower surface. On the new version this looks like it is of a slightly smaller radius. This will help to get more airflow under the nose and the more forward pillars will allow that airflow to sweep outwards to the leading edge of the car's underfloor. Both these changes will improve overall underfloor downforce, giving the car more overall grip.
9.23 **FORCE INDIA VJM07 - NEW FRONT WING (ENDPLATE)**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Force India arrived at the Red Bull Ring with a huge quantity of new parts, pushing forward some of the upgrades they initially planned to introduce in Silverstone.

The team made some small alterations to their Front Wing, especially around the endplates. The team have utilized multi element endplates since the start of the season but they've now revised the base of the trailing Endplate with the lower section cut out. These changes are designed to re-envisage what the team are looking to achieve both locally and further downstream.

The loss of 75mm either side of the front wing for 2014 obviously changed all the teams approaches, however as their packages evolve they also need to make further changes to address any issues. Or in Force India's case alter the relevant airflow structures to take into account changes made downstream, targeting improvements in tandem with other solutions.
9.24 **FORCE INDIA VJM07 - FRONT BRAKE DUCT FIN**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Force India arrived at the Red Bull Ring with a huge quantity of new parts, pushing forward some of the upgrades they initially planned to introduce in Silverstone.

Small modifications can often have a large impact, especially when they're based at the front of the car with this in mind the team added a small winglet on the upper front edge of their front brake duct.

The winglet is curved/scrolled and is reminiscent of one tried by Red Bull several races ago. The winglet is used to manipulate the airflow that is produced by the suspension, which has an effect of the components downstream like the Sidepod. This is of course a critical area, as the Sidepod (especially the shoulder) is used just as much as any other area as a way of creating downforce and moreover a large surface area that conditions flow to create airflow downstream.
9.25 **FORCE INDIA VJM07 – FRONT-WING PILLARS MOVED**


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**Force India moves front-wing pillars**

Force India has brought its front-wing mounting pillars further forward to be closer to the wing's centre of pressure. With the old design (inset), the pillars would have had to be stiffer to pass the deflection tests and the front wing would rotate forward under load, the opposite of what you want. This modified design will hold the front wing in a way that makes it more consistent. It seems that the leading edge of the nose area inside the pillars has a smaller radius. That's a small detail change to optimise the airflow under the car.
9.26  **FORCE INDIA VJM07 - NEW NOSE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Force India have utilised a ‘finger’ extension nose since the start of the season and as part of their extensive upgrade package for Austria they've made some alterations to it (upper nose). The most wide sweeping change comes with the movement of the mounting pylons into a more forward position where it mounts to the front wing increasing their involvement in the conditioning of airflow and marginally increasing the front wings rigidity under load.

This inevitably leads to an overall lengthening of the nosecone section, giving more surface area with which to condition the airflow underneath the nose, which should not only benefit components downstream but give an upshot of performance. The upper surfaces inclination from the nose tip to the most rearward section is also reduced, giving a less abrupt curve with which the airflow must face going over the nose.
9.27  **FORCE INDIA VJM07 - TURNING VANES**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Changes made to the nose and front wing mountings clearly have an impact further downstream and so the team also revised their Turning Vanes in Austria. Much like Red Bull the team have opted to flatten out the bottom section of the twin vanes which will collate the airflow passing down the outside of the chassis and re-direct it more efficiently around the sidepods, whilst protecting the airflow traveling under the nose/chassis from the wake of the front tyres.
9.28 **FORCE INDIA VJM07 - SIDEPOD AND COOLING CHANGES**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The last few seasons have seen teams designing their Sidepods not only around the requirement of cooling but to be used as an aerodynamic surface with which to create more downforce. It's a large surface area of the car and so it's an obvious area with which to shape and condition flow, of course 2012/13 was more aggressive on this front due to Coanda exhausts but the guiding principles and lessons learnt remain. If we look at an F1 car from the side we can see that the shaping of the sidepod tends to represent that of wing which of course is no mistake. The problem with any wing shaped component is that it has to be designed with care not to upset the aerodynamic balance of the car and furthermore work over a wide speed threshold. That's why we have seen teams proliferate the leading edge of their sidepods with devices that can alter the sidepods characteristics over the last few years. Force India have run with a horizontal vane protruding from the side of the cockpit next to the wing mirror this season for just this purpose, vorticising the airflow and therefore reducing the boundary layer that builds with speed.
In Austria however the team have introduced a new airflow conditioner, which looks to do both its own job and that of a leading edge device/slat. Split into two the forward most section retains it's usually purpose but the section beyond this arc's over the corner of the sidepod and reaches across the top of it to meet with the cockpit. This alters the characteristic of the sidepod making it more efficient over a wider speed range whilst taking into account the full width of the sidepod rather than the smaller section taken care of by the outgoing vane.
At the rear of the sidepod (taking into account the engine cover outlet) the team have revised their cooling options too. This means the engine cover outlet has been reduced in size and is much more shrink wrapped around the exhaust whilst the lower cooling outlets have been expanded. This additional width at the rear of the sidepods of course lends itself to implementation of the two part airflow conditioners/leading edge slats introduced in Austria too.
9.29 **RED BULL RB10 - REAR END CHANGES**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Red Bull can surely stake a claim for the best chassis on the 2014 grid with Mercedes coming in a close second but with a power unit deficit they're still pushing for more efficiency/downforce.

Red Bull's greatest asset over the last few seasons has been controlling the way in which the diffuser is sealed, clearly making huge strides with exhaust blowing to magnify this. With the exhaust placed along the cars centreline this season, sealing the diffuser by this method is all but impossible, but the teams still want to do their best to seal the diffusers edges to maximise downforce.

One of the largest factors in their quest to 'seal' the diffuser is the way in which the tyres squirt airflow laterally into the diffusers path under deformation, leading to inconsistent levels of downforce. The teams have been managing this for several seasons now with cuts, slots and strakes ahead of the rear wheels, designed to roll up and vorticise the airflow in that region, reducing the effects of 'tyre squirt'. Several races ago Red Bull redesigned their tyre squirt slots ahead of the rear wheels with a dog legged section cut out, for Austria the team arrived with a
new vertical strake design. Split into two sections, the rearward strake also has a scroll on its top edge, these strakes will work together to roll up the airflow into a vortex and reduce the impact the tyres deformation has during cornering on the diffuser.

At their home circuit the team decided to once again utilise the upper Y100 Winglet/Monkey Seat that they employed in Monaco.

They also re-introduced the small vortex generators at the leading edge of the diffuser. These small devices help to overcome the diffusers angle by disturbing the airflow, leading to a more stable delivery of downforce over a wider speed range.

Both of these additions are primarily used to give the driver more stability but will come at the expense of a small drag penalty. Meanwhile the rear wing upper flap’s V groove was also reduced for Austria which will not only take advantage of the team using the upper Y100 winglet to garner more downforce but will lead to a slight increase in drag too.
9.30  **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images from the Austrian GP courtesy of Sutton Images.

![Force India VJM07 - New Nose (upper) - note the mounting pylon shape...](image-url)
Ferrari F14T Front Brake Duct detail
Ferrari F14T front wing detail from behind
Ferrari F14T front brake detail
Red Bull RB10 front brake duct detail
Force India VJM07 new under chassis turning vanes (Flattened out at their base like Red Bull)
Force India VJM07 - New airflow conditioners, now split into two with the rear element acting as a leading edge slat over the top of the sidepod inlet.
Sauber C33 - lower downforce rear wing as used by Esteban in Canada
Force India VJM07 rear wing assembly
Marussia MR03 front wing detail from behind
Lotus E22 front brake duct detail
Mercedes W05 under chassis turning vane detail
Mercedes W05 serrated and twin element bargeboard detail (note all sections have their own chord)
Mercedes W05 rear end detail (note the tiny gurney applied to the Y100 extensions either side of the crash structure)
Ferrari F14T front wing detail from behind
Mercedes W05 Front wing detail, note the thermal imaging camera just peeping into view over the endplate
Williams FW36 front wing, the hooked endplate variant that was tested in FP sessions in Canada but not raced
Williams FW36 front wing detail
Red Bull RB10 front brake 'caketin'
Mercedes W05 Front wing detail (note the inner endplate canard)
Mercedes W05 'Bat Wing' placed astride the under chassis sensor
10. **ROUND 09/19 – GREAT BRITAIN**

10.1 **VIDEO – TECH UPDATE 2014 WITH CRAIG SCARBOROUGH**

[by Craig Scarborough from *The Racer’s Edge*]
10.2  **MERCEDES W05 - NEW TURNING VANES**


Mercedes' Silverstone set-up featured these new turning vanes below the front of the chassis. The front wing pillars pull the airflow inward to get more mass airflow between the front wheels, but as this airflow gets to the front wheels it needs to be turned outward across the leading edge of the underfloor. These new turning vanes are that little bit more aggressive and the horizontal lower endplate (red arrow) is more three dimensional. It is very difficult to change the direction of airflow, but if you understand what the airflow is doing then you can then help it to do it that little bit better. That's what Mercedes are trying here. If it can be achieved they will get a little bit more downforce and that little bit more consistency.
Mercedes have clearly made huge strides with the introduction of the new regulations this season, their chassis / power unit integration has given them an advantage over the rest of the field. However they've also made strides aerodynamically too, whether this is purely down to the curtailment of off throttle diffuser blowing affecting Red Bulls relative performance, the improvements made by Mercedes to their facilities (Wind Tunnel, tooling etc increased from 50% to 60%) or the fulfilment of years of staff building or a more likely a combination of all these factors.

Development for any F1 team needs to be relentless, whether at the front like Mercedes, or one of the rear gunners. Momentum is critical not only for morale but also to stay ahead of the competition as they have the front runner in their sights, with clear indicators showing them how and where they themselves can improve. With this in mind Mercedes have been making small but track characteristic improvements.
At Silverstone this came in the form of minor tweaks to the Sidepods Airflow Conditioners, as we can see from the image. The enlarged circle shows the conditioner from Austria, where the rearward section, which arcs over to meet the vortex generator that sits on the sidepods shoulder is much tighter on the Silverstone iteration, which leads to the forward element standing taller. Silverstones higher speed demands means that there is a premium on drag, meaning that the teams will make efforts to control the airflow in different ways. The sidepod airflow conditioners control how the tyres wake impinges on the sidepod, changing its shape also has an effect on the sidepods characteristics too.
10.4 **McLaren MP4-29 - Floor Modifications**


Part of McLaren's update package for Silverstone was a modification to the floor area just in front of the rear tyre. It is very similar to solutions used by other teams, in particular that seen on Red Bull's RB10 (inset) in recent races. Allowing airflow through this slot (red arrow) helps to manage the airflow that is being displaced as the rear tyre rotates, and the overall benefit is more underbody downforce.
10.5 **FERRARI F14T - FRONT BRAKE COOLING, PART ONE**


The airflow that cools the front brakes needs to be very well managed. The cold air comes in the main forward-facing brake duct opening (centre of picture) and passes through the cooling holes and across of the hot brake disc, taking away the excess heat. This airflow is then exited (red arrows) through the spokes of the front wheel and then mixes with the airflow that is coming around the outside of the front tyre. If any of this hot turbulent airflow is allowed to escape inside the wheel, the car's underfloor will produce less downforce, meaning the car will have less grip.
10.6 **Ferrari F14T - Front Brake Cooling, Part Two**

(from [http://www.formula1.com](http://www.formula1.com) - [illustrations by Giorgio Piola])

With the main brake duct shield removed we can see a separate cooling duct (red arrows). Efficient brake cooling means taking in as much cold airflow as possible through the main brake duct inlet (centre of picture) and letting it swirl around the disc to take away excess heat. The internal flow needs to be managed and this separate duct sets up the airflow direction, which in turn helps the airflow that is cooling the disc.
10.7 **FERRARI F14T – POWER UNIT INSTALLATION**


Mercedes' clever installation of their 2014 power unit has garnered plenty of attention, but Ferrari's solution also has some very novel features. The exhaust system (1) naturally starts on either side of the engine. With its flat-section three-into-one transition with the tailpipe, it then meets in the middle and connects with the turbo (2 - in red). A very simple stay (3) supports the overhanging weight of the turbo. The clever part of Ferrari's design is the intercooler positioning (4). Instead of the pressurised hot air from the blue side of the turbo (2) travelling to the sidepod, passing through a radiator core to cool it, and then returning to the engine, the Italian team have placed the intercooler in the 'V' of the engine (the red arrow shows the location), and the air quite simply passes through this on its normal route into the engine inlets. The intake duct (5), meanwhile, channels airflow coming from the airbox into the blue side of the turbo (2).
10.8 **FERRARI F14T - FRONT BRAKE DUCTS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Ferrari still seem a little at sea with their developments, not sure if they should flip a coin, throw a six or simply stick with what they've got. Whether they're still having correlation issues between their wind tunnel, CFD and actual track components is questionable but key areas of development seem under both constant change, back to backed for correlation and then they revert to the older components. The reduction in width of 75mm either side of the Front Wing in 2014 has led to them turning their attention to their front brake ducts.

At Silverstone the team arrived with an enlarged section of bodywork that straddles the front of the brake assembly, taking airflow collated by the scoop and re purposing it to energise the air flowing around the wheel's face. The idea is to mitigate the effect of how the airflow spills off the wheels outer face and inevitably makes controlling the wheels wake more difficult. Ferrari have tried several solutions to this since the start of the season, including using a blown (hollow) wheel nut arrangement. The problem for the team is that not only do you rob Peter to pay Paul by taking airflow via the scoop and injecting it into the wheels airflow pattern, creating some drag in the process.

It is difficult to model the region due to the combination of many flow regimes and tyre deformation having an impact on the the wake, getting it right however will provide a welcomed boost further downstream, making the effort worthwhile.
10.9 RED BULL RB10 - FRONT WING AMENDMENTS

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Red Bull are never one to settle when it comes to the quest for performance and we often see huge changes from the car that starts the season to the one that ends it. Some changes however often appear very subtle, their change to the Front Wing’s smaller, inner cascade for Silverstone is one such example.

For some time now the cascade has remained in a state of only minor flux with the leading and trailing edges seeing the most action in terms of adjustment. For Silverstone though the team completely split the already two piece element by creating a divide in the inner endplate (old one inset). On the face of it the change seems rather minor but just goes to show how the team believe even small changes can have much larger effects. The front wing after all is the first component to 'see' the airflow, with these smaller cascades helping to control the airflow around the front tyre and brake ducts.

The serration of the inner endplate is likely to aid the cascade in yaw, helping to attain the desired effect over a wider speed threshold. It's something that other teams have already done.
this season (Ferrari, McLaren...) and so is just another area where Red Bull are making leaps forward by learning lessons from others.

Having introduced an inboard endplate control vane several races ago to help with the way in which the airflow interacts and traverses the front tyre, the team revised it's design for Silverstone (circled), adopting a Z shaped vane. The Z shaping makes the vertical section act like an endplate, increasing its aspect ratio whilst the uppermost horizontal section is shaped to define the trajectory the vortex the component induces.
10.10 **Red Bull RB10 – Endplate Vane Gets Curvier**

[by Gary Anderson from http://www.autosport.com/f1]

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For all the rule changes in 2014, the aerodynamic regulations are more or less the same as last year. But one significant change is the narrowing of the front wing by 150mm. This means teams have to be more aggressive to turn the airflow around the front wheel given that, on each side, the wing is 75mm narrower.

Red Bull ran at Silverstone with a more curved turning vane on the inside of the endplate. This is designed to aid that airflow going around the outside of the tyre. By getting the airflow to go around the tyre, not only does it mean it reaches the floor in a more consistent state, but it also helps the brake cooling by pulling air through the front wheel.

Force India arguably has the best approach to this, with a number of vertical sections setting up this turning moment early on. Red Bull’s approach is more to take a well-established endplate concept and adapt it for the new regulations.
Red Bull have made numerous revisions to their Rear Wing support pylon throughout the season, with Silverstone offering the backdrop for a further modification. Changes to the 2014 regulations, outlawing the use of a 'beam wing' has led to many differing design decisions by the teams, as they look for both structural rigidity whilst maintaining aerodynamic efficiency. In the case of Red Bull it was clear from the start that the team wanted to run a singular support pylon, minimising the effect the supporting element may have on the rear wing’s main plane and top flap.

Ferrari who made wide sweeping changes to their rear wing pylon(s) in Barcelona also introduced a 'swan neck' style pylon which appears to have inspired the boys at Red Bull. The new pylon design mounted on the RB10 for Silverstone traverses the main plane and mounts to the front of the DRS actuation pod. This is a sensitive area and relies on the teams follow strict dimensional criteria in order to place bodywork here, this is due to the changes made by the FIA when they outlawed the full length shark fin engine covers and the 'F-Duct'.

The idea behind such a design is to make the main plane more efficient, as the pylon doesn't impinge upon the lower surface. The pylon being placed on the lower edge of the main plane as used to be the case can lead to airflow separation, which results in a loss of performance. This is especially critical as the car is in yaw as any loss of airflow attachment results in imbalance for the driver, this results in him having to back out which of course further impacts performance.
10.12 **McLaren MP4-29 – Floor Slots**

[by Gary Anderson from http://www.autosport.com/f1]

McLaren floor slots reduce drag

McLaren has followed Red Bull in adding an s-shaped slot in the floor ahead of the rear tyre. While holes in the floor are not legal, provided they are slots and go all the way to the edge of the floor this is allowed. As well as channelling the air around the rear wheel, reducing drag, this will reduce the interference with the diffuser and should make the car more consistent across a range of rideheights.

It's also interesting that McLaren again ran single-decker suspension blockers on each side to reduce the drag. I always expected the team would vary the spec of these according to track, but if the original underfloor was conceived with these blockers in place it would be difficult to just remove them. It appears that there is now a better understanding of how these and the floor work together, and the new floor with the trailing-edge gurney allows them to remove one of the blockers, reducing the drag of the car.
McLaren's problems have been symptomatic of the decisions they made when they first conceived their 2014 challenger. It's a difficult task as the initial layout of a car can be make or break, re-developing mass sections of car, especially when it relates to cooling like McLaren not only requires physical changes to coolers but re-envisioning of aero components. In the case of McLaren their vision was centered around a need to have enough cooling (internal space), packaging the larger exhaust Mercedes HPP had specified and of course the gearbox designed and catered for their 'wishbone suspension'. As we have seen, many of the other teams have moved toward a lower and longer line cooling outlet at the base of the car, whilst shrinking the cooling outlet around the exhaust. This creates another area of low pressure above the diffuser (slower moving airflow exiting from the rear of the car).

McLaren's 'wishbone wings' prohibit the team from following a similar path, requiring them to remove the wings and change substantial areas of bodywork. Under the old regulations this task would be large but not insurmountable however the curtailment of CFD and Wind Tunnel time makes wide sweeping changes fairly prohibitive as the teams cannot then concentrate on refinement too.
The team arrived at Silverstone with a new dog-legged slot ahead of the rear tyre, a solution we've previously seen Red Bull employ in the area. For those unfamiliar with the work done by these floor slots, their purpose is to manipulate the airflow dispatched by the tyre, especially as it deforms. The deformation of the tyre creates an inconsistent airflow pattern that literally squirts airflow laterally into the diffusers path. By injecting some of the airflow from above the floor into the lower airflows passage as it combines with the airflow dispatched by the tyre the 'tyre squirt' can be re-aligned. Minimizing tyre squirt is essential to creating more downforce with the tyre being worked (deformed) more under load (cornering).

The new solution from McLaren is used to better focus the airflow in the region and hopefully help the diffuser to operate over a wider spectrum.
10.14 **FORCE INDIA VJM07 – REAR WING SUPPORT**

[by Gary Anderson from http://www.autosport.com/f1]

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**Force India's rear-wing support**

*With the beam wing banned for this year, teams have changed the way they are mounting their rear wing. Force India is the latest to switch to a single wing-mounting pillar. Previously it had two pillars, as well as being mounted onto the floor via the endplates.*

The load is shared by the central pillar, which is curved around the exhaust, and the floor. It also means that the wing is now mounted on three points. This single pillar minimises the aerodynamic interference with the underside of the rear-wing main plane, and with the middle pillar forward this stops the wing from trying to rotate under load.
10.15  **Technical Image Gallery**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

A selection of the best technical images from the Britain GP courtesy of Sutton Images.
The F1-Forecast Technical Files
http://www.f1-forecast.com
The F1-Forecast Technical Files
http://www.f1-forecast.com
The F1-Forecast Technical Files
http://www.f1-forecast.com
11. **ROUND 10/19 – GERMANY**

11.1 **VIDEO – TECH OVERVIEW WITH CRAIG SCARBOROUGH**

[by Craig Scarborough from The Racer’s Edge](http://www.f1-forecast.com)
11.2 **McLaren MP4-29 – Serrated Rear Wing**


McLaren rushed through a new rear wing assembly for Germany. The endplates feature more louvers on the lower edge and these are increased in length to allow the low-pressure area behind the rear tyre to help scavenge the underfloor for downforce. The small turning vanes on the outside of the endplate (two red arrows on left) help the airflow on its outer surface to travel upwards, reducing the vortex that is created at the upper rear corner of the wing. This vortex creates drag, so these additions will make the wing assembly more efficient. Perhaps more interesting is the serrated slot gap between the rear wing main plane and the flap (two red arrows in centre). This concept has been used before, but as a serrated gurney flap on the trailing edge of the inset Williams assembly from 2004. The serration, primarily on the trailing edge of the main plane, will set up small vortices that when the wing is closed will travel up the undersurface of the rear wing flap, reducing the risk of airflow separation. These small vortices will also help to re-attach the airflow on the underside of the flap when the rear wing closes from its DRS open position, something that can be critical for rear-end stability at the end of a DRS straight.
11.3 **McLaren MP4-29 – Rear Wing Setup**

[by Gary Anderson from http://www.autosport.com/f1]

McLaren tweaks rear wing set-up

McLaren’s new rear wing features taller louvres on the lower edge to allow the low pressure behind the rear tyre to scavenge air from the underside of the wing and underfloor. This helps the performance and consistency of the underfloor. The horizontal louvres of the upper part of the rear-wing endplate have also been increased to reduce drag.

The small turning vanes on the outside of the rear-wing endplate set up small vortices, which act in a similar way to the vertical gurney flap on the trailing edge of the endplate by helping the wing’s underside.

The serrated slot gap between the rear-wing main plane and the flap is the most interesting part. It will set up small vortices when the DRS is operated, which in turn will help to re-attach the airflow on the underside of the flap when the rear wing closes from its DRS-open position. This is critical for rear-end stability at the end of a DRS straight.
McLaren arrived in Germany with a new rear wing with a few new distinguishing features: the endplates have each been treated to two rows of canards, which rather than being one longitudinal canard are serrated for further efficiency. This is a design that has been prevalent on the Lotus for some time, with airflow rolling off the canard at the endplates trailing edge creating vortices, which makes for an altogether more targeted flow structure in the region. The canards form part of the 20mm allowance for the endplates and so the endplate around them has to be narrower to accommodate them. The serrations are used so that the airflow works in the same manner whilst the car is in yaw, otherwise the vortex would rapidly break down as the car changes direction, leading to a loss in stability. Of course the team have opted to angle both rows of canards upward to further maximise the whole wings airflow structure, creating upwash that vicariously leads to an increase in diffuser performance too.

The team have also re-designed their Main plane and Top Flap with the introduction of tubercles to the trailing and leading edges of each respectively. Tubercles are the wave patterns formed on the edges of the wing profiles, with the pectoral fins of humpback whales being most widely associated with their use.
The tubercles on a humpback whales fins are seen as one of the primary reasons for their manoeuvrability, with them increasing the efficiency of the fins span (Research conducted around 10 years ago concluded that a humpback style fin produced 32% less drag and 8% more lift than a conventional straight edge fin).

In the case of McLaren it's interesting that they've opted to place some on the trailing edge of the Main plane skewed to the placement of the top flaps leading edge ones (like a zip). I believe this is to mainly help the upper profile, vicariously boosting the performance of both.

As two profiles are required by the regulations and inevitably a singular profile would lead to stall issues, the design and use of tubercles for the rear wing have required further investigation than simply applying the humpback knowledge. We also have to consider that DRS plays a role in how Formula One designers approach rear wing design, with implications in performance both when in use and when closed.

Starting with the Top Flap as this uses the conventional knowledge carried over from the humpback, the tubercles create a Venturi effect with the airflow being constricted by the protruding "knuckles" and allowing the airflow to pass by the shorter sections, creating narrower flow channels, that pull on the constricted flow. Much like the use of Vortex Generators on a sidepods leading edge this results in a wing that produces a wider operating window, meaning the team has much more scope in terms of angle of attack. The tubercles also reduce drag, with tip vortices curtailed by their destabilization of the airflow.
The Main plane also features tubercles (marked above in yellow) but this time on the wings trailing edge, now although this is counter intuitive to what we have just learnt in terms of the humpbacks tubercles, we must consider that there are two pressure sides to a wings profile and one cannot work without the other. I'd suggest the trailing edge tuburcles are a means to increase the speed of airflow dispatched by the main plane, allowing the lower pressure side (the back) of the top flap to work more efficiently with the high pressure side. Furthermore we must remember that the wing operates in different modes, with DRS. The opening and closing of the DRS flap during a lap can lead to instability as the airflow tries to re-attach, this can be a problem under braking and turn in, which the team and drivers would of course like to avoid.
Some smaller changes have also been made to the rear wing support Y-Lon, whilst the centralised V groove, used to cut drag has also been reduced in size. These changes are both supportive of the new tubercles which increase the wings efficiency, the change to the Y-Lon has been made in order to reduce it's effect on the main plane (especially in yaw). Whilst the span reduction of the V groove is due to the increased L/D that the wing now has.
11.5 **Williams FW36 - Louvred Shark Fin Engine Cover**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The FW36 has been a revelation this season with not only the switch from Renault to Mercedes for 2014 now seeming an inspired decision (most probably due to the Toto Wolff connection) but with the car proving to be exceptionally efficient. Over the last few seasons Williams have struggled to keep up with the development of EBD (Exhaust Blown Diffusers) whether it be the original floor mounted ones with a lack of technical prowess from the Cosworth unit, or with Renault when trying to employ the 'Coanda' exhausts. They not only struggled to model the phenomenon in CFD and the Wind Tunnel but also replicate any kind of consistent performance during GP weekends.

A return to none floor/diffuser exhaust driven regulations with the introduction of the centreline exhaust has re-invigorated the Grove based squad, whilst the arrival of Pat Symonds and a technical restructuring has also paid dividends.

With less exhaust influence the Williams team have thrived in a more aero efficient formula whilst making shrewd decisions on packaging and gear ratio selections, which are of course much heavily regulated this season. Initially it seemed this could be their Achilles heel with short ratios meaning they are always visibly in top gear (8th) much quicker than other teams, however as the season has progressed and their knowledge of the suspension setup/engine mapping has matured the team have made significant strides. Aerodynamically the team haven't been massively eager to affect wide sweeping changes either instead opting for setup changes to suit each circuits characteristics. (Lest we forget this is a team that have produced around 10 different front wings during each of the 12/13 seasons to try and affect performance with little to no performance step).

The teams most frequent changes have come in the form of cooling options with the team having used what we term a 'conventional' cooling funnel for some of the early season races, before returning to their lowline larger outlet with aspirator in China.
In Germany the team opted to race another iteration of the shark fin configuration, with additional cooling louvres placed along its length. (This had also been tested in China during Free Practice) The team also added a small gurney trim around the periphery of the lower cooling outlet, that will have a negligible drag penalty, but increase the cars cooling capacity.
11.6 **WILLIAMS FW36 - REVIVED SHARK GILLS FOR COOLING**

[by Steven De Groote from http://www.f1technical.net]

Williams introduced a new cooling solution on its FW36 this weekend at Germany by adding a series of small apertures on the legality fin of the airbox cover. The small extension on the airbox cover is there only to fit the minimum area rules of the bodywork, but Williams have found a new use by creating fins to provide engine cooling.

Many teams have small apertures in this area for cooling, but Williams' solution surely is elaborate. The team have seemingly chosen to use shark gills because they usually produce less turbulence compared to a single, larger opening.

Shark gills actually used to be a very popular cooling solution in Formula One, culminated by the championship winning Renault R25 of 2005 that brought Fernando Alonso his first World Championship. The gills as they were in use on the sidepods of the Renault however are no longer legal since the FIA disallowed any opening in the sidepod's bodywork (the same rule also bans the possibility to add numerous winglets and chimneys on the sidepods).
11.7  **LOTUS E22 - ADDITIONAL COOLING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Lotus have really struggled to realise the potential of the E22 this season with issues from the Renault power unit causing their fair share of these. However a complex asymmetric design was also bound to be fraught with issues too and makes aerodynamic changes even more difficult. With temperatures rising at Hockenheim the team decided to install and trial some additional cooling inlets under the roll hoop.

It's unclear what the team were looking to cool, whether it be an oil cooler that the team had also moved or whether it was simply just additional cooling for the power unit. The team didn't race these additional inlets however, as, as we know any additional apertures results in increased drag and so the team clearly took the decision that the cooling advantage either wasn't required in Germany or didn't supersede the drag component.
11.8 **LOTUS E22 – ENDPLATE CUT-OUT**

[by Gary Anderson from http://www.autosport.com/f1]

Lotus adds small endplate cut-out

One of the critical aerodynamic regulation changes this year was the reduction in the width of the front wing by 7.5cm on each side. This alters how the endplate diverts the airflow around the outside of the front tyre.

The new endplate on the Lotus has a small cut-out on the upper surface, with a pointed section. This works in conjunction with the curved vane behind it, reducing the airflow that wants to spill over the top of the endplate. The rest of it is very similar to what Mercedes currently uses – in that Lotus has gone from a twin vertical sideplate to a singular one, with the trailing edge exit lower and more reaerward.

This is aimed at getting the endplate to connect to the airflow that is being displaced as the tyre rotates on the ground. The low pressure area pulls the airflow around the tyre contact patch and this connection allows the airflow to be scavenged from this area more easily.
11.9  **LOTUS E22 - FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Lotus have really struggled to realise the potential of the E22 this season with issues from the Renault power unit causing their fair share of these. However a complex asymmetric design was also bound to be fraught with issues too and makes aerodynamic changes even more difficult.

In Hockenheim the team arrived with a new front wing, looking to gain balance and performance. The old wing above can be seen above whilst close images of the new wing are scarce, Giorgio Piola did manage to grab a shot of it in a similar orientation whilst it was in the garage (shown below)
As we can see the changes may not seem widespread to begin with but they will certainly have an effect, the main change is the loss of the endplates leading edge slant, whilst a small section of the front/top edge of the endplate has been more outwardly turned than the rest of it. This is something we have seen Enstone do before with the E21’s wing featuring a similar design during 2013. The positioning of the outwardly turned section also coincides with the cascades position and will help to pull outwardly on its flow regime.
Meanwhile at the rear of the Endplate the bottom section has been removed, allowing airflow to traverse from the flapped region across the footplate. Of course both changes have been made to entice the airflow around the front tyre, creating a stronger flow structure that can impact the tyres wake, increasing the floor/diffusers performance.

The new configuration was tested by both drivers throughout Free Practice but only Pastor used it for qualifying and the race (below). As we can see above the team ran flo-viz on the wing during Free Practice to correlate its credentials.
11.10 **FERRARI F14T - REAR END CHANGES**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Ferrari once again took some sideways steps in Germany with the re-introduction of a much larger cooling outlet at the rear of the car (above). The use of the cooling outlet also bought about a return of the dual rear wing support pylons, which does seem a little counter productive given that the last time the team used such a large cooling outlet it was in tandem with the singular pylon. I'd therefore suggest that the team were moreover looking for a consistent/well known baseline, as the team looked to race the car without FRIC for the first time. We know that FRIC allowed for aerodynamic consistency which is something that Ferrari have been unable to achieve successfully compared to their rivals. That however doesn't mean to say that their package hadn't been keyed toward peak performance with it, just they were unable to enjoy it to the level their rivals were.
As we can see above (arrowed) the team also added some small fins to the skid blocks trailing edge, these fins create vortices which help to keep the airflow attached, creating better stability. These vortex generating fins may have simply been a rudimentary quick fix owing to the FRIC ban to overcome some instability or part of their planned upgrades. Other teams have also run these this season including Red Bull, Lotus and McLaren.

As pointed out to me, Ferrari has been using these Vortex Generators for the last few races.
11.11 **FORCE INDIA VJM07 - IMPROVED COOLING SOLUTION**


Force India introduced a new engine cover and cooling specification in Germany. This involved moving the gearbox cooler (lower red arrow) into the sidepods, allowing the team to remove the second air inlet (middle blue and middle red arrow) that was positioned just behind the main rollover bar engine inlet (main blue arrow on left). This allowed them to shrink wrap bodywork around the engine ancillaries that bit closer, getting better airflow to the rear wing and making it work that little bit more efficiently. The changes were also meant to create more space for improvements to the team's FRIC suspension system after positive trials at the recent Silverstone test. However, like all teams, Force India chose to drop FRIC suspension at Hockenheim after the FIA raised questions over its legality.
11.12 **FORCE INDIA VJM07 – CAR COOLING**

[by Gary Anderson from http://www.autosport.com/f1]

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**Force India reconfigures car cooling**

Force India introduced a new cooling specification in Germany.

This involved moving the gearbox cooler, previously sited on top of the gearbox, into the sidepods. This then allowed removal of the inlet for this cooler that was positioned just behind the main rollover bar engine inlet. This modification has allowed Force India to shrink-wrap the engine cover closer to the internal airbox system. Doing this improves the airflow to the rear wing making it work that little bit more efficiently.
11.13 **FORCE INDIA VJM07 + SNORKEL-LESS ENGINE COVER**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Force India had a significant upgrade package in Austria refining what had already turned out to be quite a nice package for the 2014 season. The update package was however first scheduled for Silverstone and so with the team bringing it forward there were still some lingering components to come through over the next few races. The team assessed a new engine cover which repositioned one of the oil coolers, deleting the cooling snorkel and saw the introduction of an enlarged shark fin.

Now whilst this option was available to the team for Germany and was trialed during Free Practice the team opted for something a little different. They retained their original engine cover (above) but deleted the snorkel inlet and associated internal pipework, having already relocated the cooler.
The previous specification with snorkel inlet can be seen above.
One of Mercedes' secret weapons this season is the fact that their complete exhaust system is encased in a heat-containing cover. This has two benefits. First and most important is that heat is energy, so containing the heat in the exhaust system makes the turbocharger work more efficiently. This means that more energy from the turbo can be used to improve the performance of the MGU-H. Secondly, the more heat that can be contained in the exhaust system, the less heat is radiated into other engine components, so less overall cooling is required. Via Marussia, to whom they supply engines, Ferrari are also working on this area. Since Bahrain the MR03 has used a small carbon cover to simulate the bodied Mercedes solution, but at the recent Silverstone test and in Germany the exhaust has also been wrapped in a heat-resistant material. This is shown in the smaller drawing, while in the large image the red arrows show the inner part of the exhaust casing (the outer part will be fitted when the car is finally assembled). Ferrari are expected to have a similar solution for their F14T ready for Belgium.
11.15 **RED BULL RB10 - DIFFERING CONFIGURATIONS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Red Bull's pace compared to the Mercedes powered cars this season must be difficult to internalize for the team. Their aerodynamic prowess has not simply vanished overnight and they arguably still have the best 'chassis' in the field, however to try and make up the deficit during the race, they are having to give both drivers a selection of parts to cater for their needs.

At Hockenheim this meant that both drivers ran with different specification rear ends, with Daniel seemingly able to cope with a little less wing and more tail happy RB10. As we can see in the image below Daniel ran the older specification singular mounting pylon, which mounts to the underside of the main plane, less AoA on both the main plane and top flap, whilst the endplates only featured 3 louvres (which of course reduce drag).

Meanwhile Sebastian (below) ran with much more rear wing angle, resulting in him also needing to run their two tier upper Y100 winglet / Monkey Seat. The winglet / seat is used to not only create more aerodynamic consistency and balance for the driver, but also overcome the main wings higher angle of attack. The endplates on his RB10 also featured 4 louvres in the endplate, which help to reduce the tip vortices (drag) generated by the additional AoA. He also utilised the
newer swan neck style single mounting pylon, which enables the main plane to operate more effectively (especially in yaw).

Both drivers used the wider leading edge endplate tyre wake slots introduced at Silverstone.
12. ROUND 11/19 – HUNGARY

12.1 FERRARI F14T - OIL TANK REPOSITIONING

It may not be the winning car that Fernando Alonso expected - though it did come close in Hungary - but in the F14T (upper drawing) Ferrari have produced by far their most radical car of recent years. The core aim of the project was to have an extremely efficient aero package, so all the internal components were studied with this goal in mind, in order to make the rear of the car as narrow as possible and to have a very efficient diffuser. A deep step in the chassis (1) at the front improves airflow under the car (2). The car's wheelbase (4) is around 15cm longer than its 2013 predecessor (lower drawing), with the engine moved slightly forward, allowing for a longer gearbox, which notably has the oil tank housed inside its casing (3) rather than between the engine and chassis (as has been the trend for the last 16 years ever since it was reintroduced to F1 racing by the likes of the Arrows and Stewart teams in 1998). On the power unit side, the team chose a very compact packaging design for the turbo-compressor-MGU-H layout, similar to Renault's (which, as has been well publicised, turned out to be less efficient than Mercedes 'split' solution), and placed the intercooler inside the V of the engine to save space. The exhausts are also shaped to help make the lower rear 'cola bottle' section of the car narrower and more aerodynamic.
These drawings show cross sections of the gearbox in Ferrari's current F14T (top) and last year's F138 (bottom). This year's box is significantly longer and the yellow square highlights the area in which the team have housed the oil tank, inside the gearbox casing - something not seen in Formula One racing since 1998. Previously the tank was always located between the engine and chassis, minimising the necessary pipework and placing it closer to the car's centre of gravity.
12.2 **STEERING: ONE OF THE LAST BASTIONS OF MECHANICAL F1**

[by Craig Scarborough from http://www.autosport.com/f1]

Steering a Formula 1 car remains one of the simplest mechanical processes. While other driver controls have been made fly-by-wire, steering is still a physical link all the way from the steering wheel to the front wheels.

All modern F1 cars have power assistance to the steering and this remains the only area in which modern complexity overlays the simple steering system.

The mechanical link starts with the steering wheel, attached via a quick-release mechanism, to the steering column. This in turn passes through a universal joint to the steering rack. Sideways movements of the rack and pinion set-up transfers the movement to the front axle via track rods.

Of course nothing in F1 is wholly low tech; the steering wheel is a complex carbonfibre moulding hosting all of the buttons and paddles for the driver. The steering column is a mix of carbonfibre shaft with metallic end fittings. Additionally the steering column has an electrical connector embedded in the end of the shaft, to automatically connect to a corresponding connector inside the steering wheel. Thus a short length of wiring with a multi-pin connector is required to emerge from the column to connect to the steering wheel’s electronics wiring loom. The column is also required to deform in a frontal crash, so both the universal joint and a purpose-designed collapsible section is engineered into the otherwise stiff column.

But it’s the steering rack where the modern complexity creeps in. Although the rack uses a simple fixed-gear rack and pinion, its movement is aided by hydraulic power assistance. This has to be purely a mechanical system; since the 1994 driver-aid ban, no electronics are permitted in the steering system.

A hydraulic-fluid line is taken from the pump on the engine and supplies the power-steering actuator with hydraulic pressure via an intricate valve set-up. In the straight-ahead position, no hydraulic pressure is passed through the steering. When the steering column is turned, a proportional valve opens up to supply one side of the actuator’s cylinder, to help move the steering rack one direction or the other.

Without electronics, setting up such a sensitive system is a complex process. Drivers switching between teams often need some time to reconfigure the valving to suit their own preferences.

The last mechanical link is the trackrod. These arms pass from the end of the steering rack to the front uprights, each end connecting with spherical bearings.

Sitting out in the airflow, the trackrod’s shape is largely dominated by aerodynamics. Having the trackrod pivot uncontrollably on its spherical bearings would wreak havoc with aero and the rules, which demand it does not point up or down more than five degrees. So the teams use a mechanical means to keep the trackrod angle correct, usually via a pin on the outer spherical bearing riding in a slot in its mounting clevis.

As the trackrod steers the car, the pin and slot arrangement controls its angle of attack within the legal limits.
12.3 **RENAULT CONSIDERS SPLIT MERC-STYLE TURBO FOR 2015**

[from http://www.autosport.com/f1]

Renault is considering adopting the Mercedes split concept on its turbo for next season, as it works to overhaul its current F1 engine. One of the factors believed to have boosted Mercedes’ form this year is a design in which its air compressor and turbine are on separate ends of the powerplant. It is said to reduce turbo lag for improved efficiency, as well as assist with the car’s aerodynamic packaging.
12.4 **MERCEDES W05 – TUNED BRAKE COOLING**

[by Gary Anderson from http://www.autosport.com/f1]

One of the most significant factors influencing tyre temperature is the brake cooling airflow. The teams tune how this hot airflow escapes between the brake ducts and the wheel, both in terms of overall effect and on different sides of the car.

This undercut section on the left-hand outer shell of the Mercedes’ brake duct (right graphic) allows some of that cooling air to be diverted before it passes through the disc. This means that a cool air skin is reducing the heat transfer into the rim.

On the right-hand side of the car it is closed (left graphic), so that the tyre will get that little bit hotter. The reason for this is that in Hungary the left-front tyre will get hotter more easily than the right-front.

This is because the track configuration puts more of a load on the front left, which can be exacerbated when ambient temperatures are high, as they were particularly during Friday and Saturday in Hungary.
12.6 **LOTUS E22 - NEW FRONT WING ENDPLATE**


Relative to 2013 (left inset), the 2014 regulations reduced the overall width of the front wing by 15cm, or by 7.5cm per side. This changes how the airflow comes off the front wing endplate and goes around the outside of the front tyre. Appearing in Hungary, this new endplate system is similar to that currently used by Mercedes, in that Lotus have gone from a twin vertical endplate (right inset) to a singular one, with the trailing edge exit lower and more rearward. This is to get the endplate to connect to the airflow that is being displaced as the tyre rotates onto the ground. The low-pressure area behind the tyre is pulling the airflow around the tyre and if this can be connected to this part of the front wing’s endplate it will scavenge the airflow from this area much more efficiently.
12.7 **Williams FW36 – Airbox Wings Aid Airflow**

[by Gary Anderson from http://www.autosport.com/f1]
12.8 **WILLIAMS FW36 - ADDITIONAL WING ON ROLL HOOP**


In Hungary, Williams have introduced a small wing section (red arrow) just below the roll hoop-mounted on board camera. Budapest has the second lowest average speed on the calendar (Monaco being the lowest), and at this type of track drag (which this wing section will add) is not such a big issue. Instead you want to find a little extra downforce in order to give the tyres more grip. The Williams is a very well balanced and efficient car, but does not have the highest downforce in the pit lane. This wing section will produce a small amount of downforce - probably only around five kilos, but every kilo adds up to more grip. Like most developments, it is not a new idea - inset is the solution Toyota used at races like Monaco and Hungary back in 2006.
Williams arrived in Hungary having overtaken Ferrari in the constructors championship (in Germany) and wanting to keep the momentum going. Their success this season has largely been down to a very efficient design, whilst Valtteri Bottas’ talent has shone through too. The team knew that Hungary is a very different challenge requiring as much downforce as can be found and so had a few new components to bridge the gap, as Red Bull would clearly be much quicker owing to the circuit characteristics (lower top speed and more conducive to downforce).
As we can see above, the team have introduced a small winglet that sits astride the roll hoop, something that Ferrari introduced early on in the season. The idea of the winglet is to set up longitudinal vortices that not only disturb the rear wing, delaying separation, increasing downforce and reducing drag but also makes the wing work over a wider speed threshold and creating more balance in yaw.
12.10  **WILLIAMS FW36 - COOLING OPTIONS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Having utilised the louvred shark fin configuration for the first time in Germany and running the appendage for much of Free Practice you'd have thought Williams would have continued its use throughout the weekend. Just to throw a spanner in the works though the team returned to their usual louvre-less engine cover for Qualifying. That's not to say that cooling isn't still an essential element that the team were looking to concentrate on though, with the team returning to their use of their leading edge sidepod vents (circled).

The idea of course is not only to cool the power unit but to further utilize wasted airflow by energizing the sidepods top surface, increasing the airflows speed over the sidepod (Coanda effect). The Gurney trim around the periphery of the engine covers outlet was retained in order to pull the airflow through, lowering temperatures.
12.11 **FORCE INDIA CONTINUES TO SWITCH BETWEEN ENGINE COVERS**

[by Steven De Groote from http://www.f1technical.net]

One month ago, at the Austrian Grand Prix, Force India introduced a major aerodynamic upgrade package on its VJM07, including a modified nose cone and different bodywork around the engine and exhaust. The difference is obvious around the "Claro" logo when comparing the Canadian specification to the car running at Silverstone. Tighter packaging is an obvious aerodynamic advantage and proved possible even while retaining the location of the oil cooler above the exhaust pipe, fed by the secondary airbox inlet.

In the German GP weekend, the team pushed on in this direction, now relocating the oil cooler to the sidepods, ditching the secondary inlet, reducing the volume of the car's upper bodywork even further. It is unconfirmed to me what exactly was not perfectly right with this package, but it may very well be that the shift of internal components did show an issue that needed to be resolved before racing it. In any case, at the German GP, the VJM07 was equipped with a rather strange combination of designs, featuring the Silverstone engine cover but with the secondary inlet closed off, possibly relying on internal airflow to provide sufficient air towards the oil cooler.

It is obvious this was a sub-optimal solution, and at Hungary, the team turned up with its Silverstone configuration once again, leaving the secondary inlet open to feed the oil cooler. It is probably safe to assume that the team will continue to try different configurations, especially given the high speed nature of upcoming races at Spa-Francorchamps and Monza.
12.12 **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images from the Hungarian GP courtesy of Sutton Images.
13. **ROUND 12/19 – BELGIUM**

13.1 **OVERCOMING THE PROBLEMS OF F1 WEATHER FORECASTING**

[by Craig Scarborough from http://www.autosport.com/f1]

The rain is never far away at Spa, but because of parc ferme rules in Formula 1 today, there isn’t the same scope for the full-wet set-ups of the past. Even so, there is a surprising amount that can be achieved simply by changing tyres and making in-cockpit adjustments.

It’s rare for a weekend to be wet throughout, and much more common for rain to fall during a session or during the race. If teams knew for certain that a race was going to be wet throughout, they could compromise qualifying for a wet-race set-up. The risk with this is if the rain doesn’t appear, that makes it a gamble. So changing car settings for wet sessions tends to be done within the limited parameters of parc ferme. The primary choice here is the tyre, as teams have the option of an intermediate or full wet.

The biggest risk in the wet is aquaplaning. This can happen both with the tyres riding up over the surface water and losing all grip, and also with the car’s underbody. The 100mm-wide plank under the car is the lowest point of the car and can cause aquaplaning.

In the old days a team would have to raise its car’s rideheight to overcome this, but this is now done with larger-diameter wet-weather tyres. Both sets and inter are 10mm larger in diameter, raising the cars rideheight by 5mm each end — a significant lift considering the low rideheights used in the dry.

With wet-weather tyres fitted, the team can only make adjustments to the car through the steering wheel controls and front-wing flap angle. While this seems limited there is a wide scope of parameters that can be altered here.

The steering wheel has a multifunction dial to specify what tyres are fitted to the car. Dry, inter and wet settings tell the ECU what diameter tyre is fitted, which will alter various settings, such as the pitlane speed limit. Robert Kubica was once hit with a pitlane speeding penalty for failing to change this setting to account for the different diameter of tyres.

The driver can also change engine settings to soften the power delivery and ERS harvesting. Brake bias, throttle pedal maps and gearshift maps can also be softened for the conditions. Lastly, the driver’s key handling/tuning option, the differential, can be adjusted for a different tightness on corner entry, mid-corner and corner exit. This will dial in/out understeer and traction issues.

Once the car is in the pits, the team can also alter the front-wing flap angle, adding more front downforce to suit conditions.
For many years Formula One cars have traditionally mounted the oil tank at the front of the engine (red arrow on the inset Mercedes layout). This serves two purposes: it helps move weight to the centre of the car, and also allows teams to use a taller - and therefore more efficient - oil tank design. With the changes for 2014 making the power unit far more complicated to package, Ferrari have decided to go back to a bell housing/front of gearbox-mounted oil tank (red arrow on the Ferrari engine) to help them optimise the F14T's aerodynamic design. In addition, they have also mounted the MGU-K (blue arrow) on the back of the engine. Mercedes and Renault, by contrast, have the oil tank and MGU-K mounted on the side and towards the front of the engine.

Ferrari have had to increase the wheelbase of their car to achieve this more aerodynamically efficient layout, and have also had to incorporate an extra gear train to connect the MGU-K to the crank shaft. These are small sacrifices, however. A far bigger one perhaps is that the layout reduces their ability to centralise the mass weight of the car. That is critical to reducing inertia - important because a car with lower inertia is easier to drive at, or near, the limit of adhesion. With Ferrari engine deals, Sauber and Marussia will also be using the same packaging.
13.3 **Ferrari F14T – Front Wing(s)**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

The first race after the summer break always provides us with the opportunity to see new parts on the cars, especially as Spa is quite a unique challenge. Long straights combined with a tricky second sector demands a compromise between drag reduction and downforce.

Ferrari have arrived in Spa with several Front Wing configurations to test ahead of qualifying, all of which will have different direct and downstream effects. The first of which has featured for several races now but has the upper flap cut down considerably at the adjusters end. This is done to reduce drag at higher speeds but will come at the cost of downforce at low speed, perhaps inducing a little understeer.
The second is wing more specifically keyed at low downforce circuits, meaning it was only be tested in Spa ahead of the lower downforce configuration required for Monza. The cascade element that is ordinarily used to direct airflow up and around the front tyre is replaced by two vertical fins, these two are used for a similar purpose but their effect will be reduced. Again this is a response to the need for less drag over these next few races.
Above: This image is from Piola/Omnicorse
13.4 **FERRARI F14T – REAR WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Spa's unique circuit characteristics demand good top speed for the 1st and 3rd sectors whilst retaining a high level of downforce for sector 2. This therefore makes for an interesting decision process when designing/selecting a rear wing, with most of the teams bringing a new specification of rear wing to cater for these demands, Ferrari are no exception.
Of course they completed correlation work to assess its merits in comparison to the standard specification too (below).

The newer wing (top and below) features a much shallower angle of attack for the Mainplane and Top Flap, whilst the endplate louvres which are used to reduce tip vortices are reduced from 5 to 3 (owing to the shallower AoA). The chance of rain for qualifying/race and/or down to assessment work conducted in FP1&2 we may still see Ferrari run with the older specification as a precaution.
NOTE: As this piece was written after FP2 you should be aware that both drivers opted for the higher downforce wing for qualifying/race day.
13.5 **Red Bull RB10 - Lightweight Brake Assembly**

As Spa-Francorchamps is not a particularly heavy circuit on brakes, the teams tend to use quite light braking assemblies here. Red Bull always try to be right on the weight limit, especially with the non-suspended parts of the car. Hence in Belgium the RB10's disc assembly has a new, lighter fixing bell. Note the number and size of the multiple holes (red arrow), all of which help cut weight.
13.6 **RED BULL RB10 – REAR WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Red Bull's strength over the last 5 or so years has been their ability to generate more efficient downforce than their opponents. So it comes as no surprise that at Spa a circuit where being fast in a straight line is one of the largest performance factors, we see them utilize a skinnier rear wing. Of course in 2014 they're not only considering the deficit to their rivals in terms of direct aerodynamic drag reduction, but also with a top end speed disadvantage from the under-performing Renault powerunit, they have to make up further ground.

Progress will have undoubtedly have been made by the French engine supplier over the summer break, with work continuing with Total (fuels and lubricants) to harness more power. That's not to say that Mercedes/Petronas and Ferrari/Shell haven't also been working hard on their fuel blends too though, making a gain on them even more difficult.

As we have seen in previous seasons Vettel (above) tested a different wing to his Australian counterpart with Ricciardo opting for perhaps the more aggressive solution, whereas the German retains a similar specification to the last few races, albeit with less Angle of Attack.
The rear wing being used by Ricciardo (above) features an extremely low angle of attack, something only marginally eclipsed by a Monza specification rear wing in previous seasons. Red Bull's use of the secondary (upper) Y100 Winglet / Monkey Seat has been curtailed too, with it deemed unnecessary with such a low AoA rear wing. They retain the lower (beam wing slice) Y100 Winglet / Monkey Seat however, which retains its purpose of connecting the lower airflow structures (Diffuser/Floor) with the exhaust plume.
The wing itself has had the leading edge tyre wake slots deleted and as the AoA is so low, they don't see the need to include louvres ahead of the wing planes in order to reduce tip vortices. Interesting though the top edge of the endplate has been made extremely thin to maximise the available width of the mainplane and top flap (see below).
The central support pylon has also been moved rearward, meeting with the mainplane (around halfway along the x axis) rather than on the leading edge like other solutions. (Vettel's variant utilises the swan neck style approach) This moves the pylon out of the sensitive area on the
leading edge of the mainplane, allowing the wing to generate downforce that may be lost if flow separated with a pylon mounted further forward. Lastly due to the AoA/Height of the mainplane/top flap a much smaller/longer DRS actuator pod has been commissioned (see above)

It could still turn out that Daniel was simply testing this wing for use in Monza, however it appears that he is far less sensitive to a loose rear end than Vettel, probably owing to his time spent at Toro Rosso with a less aggressive blown diffuser over the last few seasons. IF they choose to run different specifications for qualifying/race it'll be interesting to see the offset in terms of tyre degradation, where Daniel should suffer from graining much earlier into the race due to the lateral loads put through the tyres in sector 2.

Note: As this analysis was written post FP2 I can now confirm that both Red Bull drivers used the skinnier rear wing for Qualifying/Race even with the damp conditions.
Mercedes introduced a new more efficient rear wing for Belgium. The trailing edge of the main flap is curved to give a shorter cord section at the intersection with the rear wing endplates and where the slot gap separators keep the wing sections from deflecting. Both of these areas generate a vortex which creates drag, so the shorter cord will reduce that vortex and in turn the drag, which will mean for the same downforce level they will have a higher top speed. During practice Mercedes ran with a gurney tab (red arrow) along the trailing edge of the rear flap. However, as the cars go into parc ferme conditions when they leave the pits in qualifying - and you are therefore not allowed to adjust the rear wing settings pre-race - they removed this gurney tab before the session to improve straight-line speed, which is vital for the race. They also fitted a new reduced-section monkey seat wing underneath the upper wing. This gives a small amount of downforce its own right and also helps the centre section of the upper wing to work more consistently.
13.8 **MERCEDES W05 – WING REDUCES DRAG**


Mercedes introduced a very contoured rear-wing flap. The main areas of drag on the rear wing are the outboard edges where the flap joins the endplate. The vortex goes on behind the car and you have to drag it round. At this intersection, you have three different air speeds — the positive pressure on top of the wing, the negative pressure underneath and the freestream pressure passing by. The cutouts on the endplate help to reduce that effect.

The middle two dips in the rear-wing flap are where the slot-gap separators meet it. When you do that, you are attaching a vertical element to an aerodynamic surface, which also creates vortices and drag. This design mitigates the problem.

Mercedes also has a saddle wing hung off the centre pillars of the rear wing to gain downforce, with the exhaust-gas speed helping to accelerate air over it.
Mercedes introduced a slightly modified nose in Belgium, slimmer in the side walls and with a greater blend radius allowing the airflow to get out around the sides of the nose with less resistance. This improves the performance of the front wing and the underfloor. Another key benefit is that it is lighter (and hence needed to undergo another crash test). Since the beginning of the season Mercedes are believed to have saved 8kg on bodywork pieces alone. Assuming the car was over the minimum weight limit, this saving is worth something like three-tenths of a second per lap. If it was on the weight limit then it allows the team to place the weight in a lower position on the car, again improving lap time and, more importantly, tyre degradation.
13.10 **MERCEDES W05 – REAR WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Mercedes have introduced a new rear wing for Spa and will utilise the more simplistic Monkey Seat / Y100 Winglet that they tested at the post Silverstone GP test. These changes are of course made inline with their ambition of reducing drag, on a circuit that demands both fantastic top speed whilst maintaining a good level of downforce for the tricky 2nd sector. It's a tough balance for Spa as too much drag reduction will hinder downforce generation and visa versa.
Therefore the rear wings main change comes to the top flap, which features curved outer profiles on the trailing edge. This alludes to how the tip vortices would form, which can be both destructive in the creation of downforce but moreover create areas of separation which in turn creates drag.
The slimmer Y100 Winglet is used in order to change how the flow structures interact with one another, Mercedes have been keen to utilise what energy is expended by the exhaust for aerodynamic gain this season. Utilising the exhausts energy to unify the airflow structures created by the diffuser and rear wing, this is further assisted by the Y100 winglets interaction with the exhaust plume. The more complex winglet that has been in use up until this point will of course manipulate the exhaust plume and surrounding airflow differently to the new slimline version, with the newer winglet aiming to reduce drag inline with the re-design of the rear wing.
13.11 **MERCEDES W05 – RESTRUCTURED NOSE, TURNING VANES & BRAKES DUCT FIN**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

As we know the pace at which Formula One moves and develops is phenomenal and even though Mercedes lead the way, they're still introducing parts to improve performance and keep the gap to their opponents.

In Spa we can see that the team have made some modifications to the nose in order to maintain that development curve. The upper surface of the nose seems a little steeper, which in turn allows the lower section to be raised, facilitating more airflow to pass under the nose. Furthermore the top surface of the nose is more concave, allowing airflow from the upper surface to bleed off, reducing pressure on it. Making the surface more convex at the outer edges, makes the pylons seem more widely spaced, although their position is retained it will have an effect on the airflow. It's worth noting that this also seemingly reduces the height of the FOM camera handlebar style mounts, changing how the airflow interacts in unison with the suspension.
The changes to the nose tie into the team increasing their turning vanes from 3 part appendages to 4, with more mass flow for them to deal with.
A small change to the teams brake duct is also a worthwhile subject to touch on too with a small vertical blade added above the brake scoop. This blade will create a vortex similar to the one already being generated by the upper surface of the brake scoop, working together these vortices help to control some of the wake induced by the rotating tyre outbound of it, reducing the impact it has on the additional mass flow being generated under the nose.

An upshot in performance won’t all come directly from these changes with gains being seen further downstream too as the area provides a critical transition, with airflow migrating toward the splitter, bargeboards and around the sidepods undercut. The quality of this airflow will further enhance the performance of larger aerodynamic surfaces such as the sidepods, floor and diffuser.
Above: Mercedes engineer takes pictures of how the flo-viz that has been applied under the nose is migrating
Mercedes introduced a considerable update package at Spa, making sure they kept their advantage to the competition. Possible the most important of those updates was the revamp of the car's nose cone which required a new crash test. The new solution is smaller at its bottom and also slightly higher at the top - note how the supports for the cameras have become shorter. This not only gave aerodynamic gains, but according to G. Piola this also helped to reduce weight, a feature that was arguable the primary purpose of this update. It was reported that, including the team's latest package, the car is now 8 kg lighter than at the beginning of the season, allowing to move ballast rearwards to improve traction - even though this is still strictly limited by the regulations on weight distribution.
In combination with the new nose cone, the team also modified the turning vanes underneath the nose. Running a three-element solution for most of the year, they introduced a turning vane which consists of four elements to separate the airflow blocked in between the front wheels more precisely.

The rear wing was revised for the penultimate European round. The height of the moveable flap was decreased and to reduce drag its leading edge was cut in in four points forming a trio of waves. On Friday the team ran it with gurney flap which was then removed come qualifying.

Finally, the team also reverted to the basic one-flap monkey seat which was seen at the post-Silverstone tests, possibly a better solution for the lower downforce requirements of Spa-Francorchamps. It is hence reasonable to speculate that either this specification, or no monkey seat will be used at Monza.
13.13 **McLaren MP4-29 - Low-Downforce Rear Wing**


McLaren introduced a new, low-downforce rear wing for Belgium, utilising the same toothed slot gap concept seen in Germany, but in revised form developed specifically for the unique Spa-Francorchamps circuit. On this version the teeth are only on the leading edge of the flap. The teeth induce vortices traveling up the lower surface of the flap, helping the airflow on the underside of the wing to re-attach faster after the DRS has been used, which aids braking stability. New rear wing endplates were also introduced with no turning vanes on the outer surface, and the monkey seat (inset) was removed, both changes made in the interests of drag reduction.
McLaren have arrived in Spa with several updates, looking to increase the performance of the MP4-29, mainly centred around improving the airflow structures at the rear of the car. As we have seen over the last few races the team have started to move away from the use of their 'wishbone wings' as the concept although sound hasn't produced the type of performance they require. Furthermore as the design of many components was made to cater for them making widesweeping changes has taken time.

Performance from the diffuser is obviously critical and the use of the 'wishbone wings' meant that the design of the diffuser needed to be keyed directly to their design. Owing to the flow structures generated by the 'wishbone wing's' and how they interact with the diffuser, pulling upward on the diffusers airflow. With only the lower suspension elements shrouded by the wings for Spa the team have sought to re-design their diffuser to compliment the change. The upshot will likely be a reduction in drag (diffuser's tend to provide less drag for the amount of downforce being generated than their wing counterparts, however with the wishbone wing intrinsically linked to the airflow structure, their L/D was plausibly much higher than their
ponents) and a more consistent (if lessened) quantity of downforce (shifting the peak window). The re-design all features something from the Mercedes locker with the central portion of the diffuser featuring a U bend.

The U bend is a clever use of the regulations as not only does it allow access to the starter motor hole that others have had to hide with a hinged access flap, it also serves an aerodynamic purpose. Performance won't be significantly higher from this small addition but it will likely add some much needed consistency to the ebb and flow of how the diffuser generates downforce. The U bend funnels airflow from above the floor and injects it into the diffusers path, aiding with the connection of flow structures above.

Also worth noting is McLaren's continued use of the small vortex generators on the transition line from the plank to the diffuser.
McLaren have arrived in Spa with several updates, looking to increase the performance of the MP4-29, mainly centred around improving the airflow structures at the rear of the car. As we have seen over the last few races the team have started to move away from the use of their 'wishbone wings' as the concept although sound hasn't produced the type of performance they require. Furthermore as the design of many components was made to cater for them making widesweeping changes has taken time.

With changes to the 'wishbone wings' and diffuser already mentioned: McLaren MP4-29 - Diffuser - Spa must now turn our attention to their new rear wing. Having implemented several design changes to their rear wing in Hockenheim which was used again in Hungary and with a switch from high to medium downforce (with a large emphasis on drag reduction for the long straights) the team introduced another new design.
The top flap retains the leading edge tubercles introduced on the wings predecessor, retaining with it the increased L/D they create. The mainplane however returns to having a regular trailing edge but has been redesigned with a curved leading edge, as the outer sections curve upwardly to reduce drag but also maximise downforce. The canards added to the outside of the endplates in the last update have been removed as their purpose was to help unify the airflow structures in the region, which in turn will have a small drag penalty. Whilst the louvres, used to minimise tip vortices have been reduced from 5 to 3, owing to the reduction in angle of attack of the top flap and mainplane.

Also worth noting is that the team are not running their Y100 Winglet / Monkey Seat this weekend (usually attached to the Y-Lon).
13.16 **McLaren MP4-29 – Rear End Vortex Control**


McLaren continues to run a 'saw-tooth' slot gap, although the rear wing was in low-downforce trim for Spa. Whenever you shut the rear wing by deactivating the DRS, you want to get the airflow to reattach as quickly as possible so you have maximum downforce. The teeth generate vortices when open that help to increase the speed of the air through it. These same vortices help the airflow to reattach when you close it before disappearing completely when it's shut.

McLaren ran with the single deck of suspension blockers at Spa. This helps the airflow to reattach in the diffuser after it stalls as a result of getting too close to the ground. This reduces the drag and, even if the influence on the floor is slightly reduced, it works well enough for Spa. The blockers may still come and go depending on the track.
It's no secret that both Ferrari and Renault have failed to live up to the benchmark set by Mercedes with the 2014 power unit. As always, that doesn't stop manufacturers trying to make up ground though, with both Ferrari and Renault making strides since the start of the season. Fuel has provided the platform for large performance gains in both cases, with new blends being used to facilitate better power and performance as the teams look to extract more from their race allocation of fuel. This is an area that Mercedes and Petronas bested their adversaries with before the season commenced and so perhaps have less to gain as the season continues.

Marussia tested (at the post Silverstone test) with their exhaust primaries wrapped, to see what sort of performance gains could be made. It's something that the other teams have been doing since the start of the season and so it has been one of those head scratchers as to why Ferrari hadn't adopted it before now. Questions were raised after the Marussia test as to the legality of the Ferrari teams deciding to wrap their exhausts mid season, owing to the homologation regulations. I've been steadfast in my opinion since then that this practice is legal as they're not changing the specification of exhaust simply heat wrapping it. Of course there are compound
effects of heat wrapping an exhaust, as it will increase the exhaust gasses potential velocity. This increase in exhaust gas velocity increases the turbochargers potential which in turn increase the MGU-H's potential to harvest energy, passing it either directly to the MGU-K for instantaneous power or to the ES (Energy Store) for later deployment.

The increased temperature and velocity of the exhaust gases driving the turbine will of course change the requirements of the fuel being injected into the cylinders, producing more power. This development will undoubtedly have implications for Shell, as temperature (especially EGT, Exhaust Gas Temperature) will play a crucial role in their fuels development, giving them another opportunity to make incremental gains.
As we can see from the images above, Ferrari have 'bagged' their manifolds rather than using exhaust wrap, this will have a slightly different effect and of course comes with a slightly higher cost. It's difficult to proportion a power figure to this heat enclosure method as I've seen 20bhp banded around on other sites. I'd be weary of giving actual figures and ask that people not only look at the additional top end performance that it achieves but the compound effects we see with fuel, ERS etc.

Images in this article originate from AMuS
13.18 **FORCE INDIA VJM07 - NEW Y100 WINGLET / MONKEY SEAT**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Having made their largest upgrades in Austria with a few straggling through for the Silverstone weekend Force India have another change this weekend which will impact those that went ahead of it.

The Y100 Winglet or Monkey Seat as we know it is an area that is constantly under scrutiny by the teams as any changes to the exhaust, rear wing, diffuser etc require minor alterations to it in order to extract the best performance.
Their new winglet is extremely reminiscent of the one used by Lotus in 2013 as they continued to assess the merits of their DRD (Drag Reduction Device), just as I talked about back then the curved winglet acts as a mini diffuser (venturi) expanding the airflow passing by it. In the case of Force India we can see that ahead of the winglet the team have shaped their exhaust surround/pylon to create an inverted nozzle (when compared to the winglet). These two components work in conjunction with the exhaust to pull airflow through and over the engine cover/sidepod bodywork.
13.19  **CATERHAM CT05 – NEW NOSE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The CT-05 certainly wasn't going to win any style awards when the team unveiled the car at the start of the season (above), with perhaps the most hideous interpretation of the 'finger' nose on the grid. Their latest design however is much more aesthetically pleasing but more importantly may unlock some further aerodynamic potential in the car.
The more svelt vanity panel section above the finger extension is reminiscent of the Sauber C33, but unlike Sauber the team haven’t used conventional connecting pylons but instead use much shorter ones, connected to the lower part of their nose. As only the upper section of the nose has been altered and not the structural part it’s unlikely the team performed another crash test.

In terms of aero the old nose was an extreme attempt at retaining the high nose seen prior to the new rules, in an attempt to drive airflow on mass under the car. However quality trumps quantity every time and so the new design, although seemingly more conservative will likely yield better results downstream.
13.20  **CATERHAM CT05 – ENGINE COVER**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Caterham arrived after the summer break looking to chase down their closest advisory: Marussia. With this in mind the new owners had given a raft of new performance parts the green light as they chase their rivals for the all important 10th place. (Although Marussia are currently in 9th, owing to a bad season for Sauber)

Part of the upgrade package was a new engine cover/cooling outlet, which looks to make better use of the region, not only by dispatching of the un-wanted latent powerunit heat but also by improving airflow, especially in the coke bottle region.
Smaller, shorter and wider channels on the outside of the cover (terminating ahead of the suspension) allow for a tighter inner cooling outlet which of course creates more room for the airflow to migrate around the coke bottle, increasing the performance of the floor and diffuser.

Also worth noting is the new paint scheme on the Caterham, dropping the mixture of Green, White and Black down to just Black might not seem like a huge weight saving but every little
matters. Furthermore this is a recognized Colin Kolles tactic (weight reduction) in order to gain competitiveness.
It's a God's gift, Caterham’s new nose cone on the CT05. While the visual appearance may not have been the top priority for the team in terms of aerodynamic development, the modified nose cone is a whole lot better looking that before. True, it could still be better, but such as the rules that strange looking noses are currently a good solution to keep airflow underneath the nose. In any case, Caterham did not change much to the concept of its car, retaining the matte black cone that forms the front crash structure. Above that however is now a much more elegant structure, slightly rounded at the top and including a vanity panel to create a smooth, continuous upper surface towards the monocoque. With the team not modifying the front suspension, it's good to see how much higher the nose is around the upper wishbone, while at the bottom, at the connection point of the pull rod, the bodywork is more rounded.
13.22  **CATERHAM CT05 – REAR WING ENDPLATE STRAKES**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

As part of their raft of upgrades introduced in Belgium the team made changes to their rear wing endplate strakes.
The new strakes (lower of the two images) are certainly more complex and will not only assist the diffuser in managing the effects of tyre squirt, but also assist in creating upwash. Although fairly innocuous the role of the diffuser strakes shouldn't be taken likely, as if designed in sync with other components they can have a marked performance advantage.
The last stop before the summer break being Hungary meant the team bolting on as much downforce as possible but the return to racing at Spa offers a new challenge. The 7km circuit has some of the longest straights on the calender but also has its fair share of complex corners, making it a challenging place for the teams to get their aerodynamic packages right. Rather than produce a race specific rear wing the team have returned to a specification last used in Montreal.

The wing features a much lower angle of attack than usually utilised with just two *louvres placed in either endplate.

*Louvres are used to reduce tip vortices (which of course there are less of when less AoA is run)
13.24 **LOTUS E22 – WINGLET HELPS MANAGE AIRFLOW**

As we know the E22 sports several asymmetric components already but in Spa the team decided they would also change their approach to cooling the car in this way too. As we can see the left hand side of the car, which houses the chargecooler setup had a significantly larger cooling outlet when compared with the right hand side. With the size of the cooling system inside the sidepod seemingly increased for Spa the team decided that this shouldn't affect the other side of the car and ran a much smaller cover on the right. I'm still not wholly convinced by the teams asymmetric philosophy especially owing to its aerodynamic impact, but on a circuit dominated by long straights, perhaps it was simply a case of their drivers being aware of the balance issues in sector 2.
14. **ROUND 13/19 – ITALY**

14.1 **RED BULL RB10 FRONT WING**


Like Ferrari, in Italy Red Bull used a front wing design (left) based on the one (right) they introduced at last year's Monza race, but without the L-section upper flap (red arrow). Given their acknowledged power deficit to their Mercedes-engined rivals, the team knew that a very low-downforce set-up was their only chance of staying in touch around the high-speed circuit. The ploy worked as well as could be expected, with Daniel Ricciardo and Sebastian Vettel finishing fifth and sixth respectively as the leading non-Mercedes runners.
14.2 **RED BULL RB10 REAR WING**


Starting with the low-downforce rear wing introduced at the last round in Belgium as a basis, Red Bull ran this design in Italy. It features an even lower-downforce main plane, but with a shorter chord, and retains the same endplates, but with no gills.
14.3 **RED BULL RB10 – LOSE THEIR BEAM WING SLICE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Since the start of the season Red Bull have approached the loss of the beam wing differently to the rest of the field. As we can see below the team have continued to place a slice of beam wing in the Y100 position that the old beam wing used to occupy.

![Red Bull RB10 beam wing slice](image)

It's used in order to unify the airflow structures in the region, connecting the diffuser with the exhaust plume and that with the rear wing. For Monza (below) the team have done away with the slice, in order to reduce drag. Connecting these airflow structures of course increases downforce and although we often tend to agree that the diffuser creates less drag for the amount of downforce it can generate, (when compared with a wing) creating upwash structures (of which the Y100 beam wing slice assists in) inherently lends itself to an overall increase in drag.
14.4 **RED BULL RB10 – CASCADE LESS FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

It will come as no surprise to those that follow the technical nuances of Formula One that Red Bull have opted to run a cascade-less front wing in Monza. Even with closer engine parity in 2013, the Milton Keynes based squad opted to run with outwardly less complex wings for the Italian GP. The loss of the cascades of course compromises the RB10 throughout the corners but on the long straights of Monza, the reduction in drag they create is much welcomed.
As Christian Horner remarked they ran the lowest downforce option they could in Monza 2013 whilst engine parity was pretty close, making it even clearer how well Red Bull, Renault & Total have done to close some of the performance gap. The loss of the cascades means that the airflow that would normally be turned outward or over the tyre is not conditioned, this of course leaves the tyre wake to do it's own thing, however without the interference the airflow moves more smoothly and thus drag is reduced.
14.5 **VIDEO – RED BULL-LOTUS-RENAULT TECH OVERVIEW WITH CRAIG SCARBOROUGH**

[by Craig Scarborough from *The Racer’s Edge*]
14.6 **VIDEO – FERRARI TECH OVERVIEW WITH CRAIG SCARBOROUGH**

[by Craig Scarborough from *The Racer’s Edge*]
14.7 **Ferrari F14T Front Wing**


For qualifying and the race in Italy, Ferrari - like last year - are using a new front wing with the upper forward flaps replaced by two vertical turning vanes. Of course the two designs are different, since this year's must be narrower to comply with regulations. Note also the difference in the main plane and standard flap - the F138 had a single-flap solution, while the current F14T has kept a three-flap layout. This gives more consistent airflow to the underfloor of the car.
14.8 **FERRARI F14T – CASCADE LESS FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Ferrari continue to try and hold onto the coat-tails of Mercedes and Red Bull, utilising a cascade-less front wing in Monza (tested in Spa) that looks to minimise drag. Nearly 70% of the lap of Monza is spent at full throttle and so Ferrari are clearly giving up some of their potential downforce in order to reduce drag.

Gone are the cascades that are normally placed on the outer section of the wing and are used to shape the airflow that is dispatched by the front tyres. The manipulation of this airflow leads to an increase in drag and so at a circuit that demands a higher top speed the team make sacrifices. That's not to say they aren't still looking to manipulate the airflow around the front tyres, with two vertical vanes replacing the cascades, creating vortices that turn the flow outward.
14.9 **Ferrari F14T – Rear Wing**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Lessons were learnt in Belgium with the team trialling a wing that the team have bought to Monza in order to reduce drag and increase their top speed.

The team however continue to play devils advocate with several iterations run throughout the weekend in order to asses which would give the best qualifying/race pace offset. The different configurations run all hinge on the same wing, the one shown above is the main design, which when compared to their regular wing has a lower angle of attack, which of course means the quantity and position of louvres is adjusted.
In the image above we can see that the team also compared the standard issue wing, with the gurney trim removed. This will reduce the ability for the wing to generate downforce but will also reduce drag.
The team also trimmed the top flap down further to see just how much downforce/drag they could drop. You'll note that the V grooves have seemingly disappeared and slot gap separators seem to have grown in size due to this (although they haven't it's just the reduction in flap height).

Both drivers opted to run qualifying with the gurney trim removed but no further trimming done to the top flap.
14.10 **FERRARI F14T - DIFFUSER**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Ferrari's on/off approach means that we often see the team try things that either get thrown into the parts bin never to see the light of day again, or flip flop between configurations until it's finally decided one is marginally quicker than the other. That's the thing with Formula One, we are dealing with tenths or hundredths of a second, the margin between one component offering performance sometimes isn't as tangible as simulations predict. Ferrari have been living this hellish situation for several seasons now and thought they'd turned the corner at the start of the season when they re-opened their wind tunnel at Maranello. I'm yet to be convinced though, the rate at which parts are placed on the car to have their performance to be ratified yet the old part still raced is staggering. They clearly have an offset somewhere between their CAD/CFD models, scale wind tunnel models and the full blown parts, until they find this they will continue to languish behind their bitter rivals.

Looking more outwardly though we must also consider that perhaps the steps just aren't large or fast enough when compared with their rivals. Currently when Mercedes or Red Bull bring new components, more often than not they test it, the results correlate and they race the components. The one foot through the door approach from Ferrari leaves them several paces adrift but also means their rivals edge a little further away as they dilly dally. I often wonder why they don't have the conviction to proceed with parts even if they don't seem to give the performance gain they should show. This probably lies within the offset between qualifying and race setup, with the team playing devils advocate as they try to either retain grid position or think of their race pace.

In Monza the team deliberated over a new diffuser design, which featured a change to the central portion an area that has seen revision earlier in the season.
Above: The F14T's central portion of the diffuser featured a lowered section that allowed the floor to interact with diffuser earlier on in the season.
Above: The diffuser that has been in use since features a more aggressive central angle of attack (steeper) with the uppermost section running inline with the rest of the diffusers upper surface. The upshot of which will be more of a peak downforce bubble and a more aggressive interaction with the airflow structures above.
Above: The diffuser tried in Monza was more of a halfway house, retaining most of the AoA in the central section, with the curvature along the top edge allowing the floors flow structure to interact differently. I'd suggest that the team were trying to soften the connection of airflow structures, in an attempt to reduce drag at the compromise of some downforce/balance.
14.11 **FERRARI WING WINS BEAUTY CONTEST**


If you look at this front wing, or that of the Red Bull, they look beautifully clean.
It's a shame nobody takes a walk down the pitlane and writes a regulation to make them the norm, rather than just for low-downforce circuits.
By removing the cascades and shortening the upper lip, it trims out the downforce without hurting the airflow to the back of the car. This makes sense because it cuts the drag without changing the airflow characteristics that the car is conceived around.
Ferrari did stick with the two turning vanes, which help turn the airflow around the front wheels.
In Italy McLaren are using the same rear wing introduced at the last round in Belgium, a low-downforce version of the radical high-downforce design debuted at Hockenheim (inset). That had shark's teeth on both the trailing edge of the main plane and the leading edge of the flap. The Monza version features a new main plane without teeth, but retains the teeth on the flap. These teeth help the airflow to re-attach to the under surface of the flap when the DRS is closed at the end of the straight. Compared to Red Bull (who use Renault engines), Mercedes, Williams, and McLaren (who all use Mercedes engines) have all opted for a higher downforce level to have better race pace in terms of tyre wear.
14.13 **WILLIAMS LOW-DRAG REAR WING FOR MONZA**

[by Steven De Groote from http://www.f1technical.net]

Similar to most other teams, Williams have introduced a new, one-off rear wing to adapt to the requirements of the Monza Autodrome. Focusing on top speed, drag shedding is the easiest with a smaller rear wing, given that the rear wing generates much more drag per point of downforce compared to the diffuser. This also explains why teams are never modifying their diffuser, simply because it's more efficient and probably more complicated to alter as well.

The new rear wing fitted in the FW36 features an identical endplate as the one in Belgium, except for the reduced amount of louvres. This has been reduced to one as more are hardly needed due to the smaller angle of attack of the rear wing. The design of the rear wing itself means there are less strong wingtip vortices anyway, so less louvres are needed to help reduce them.
Perhaps the most interesting design feature of the team's Monza rear wing is that they put in the effort to create a new fairing for the DRS activator in the middle of the wing. While the one at Spa was still a big hub to help control airflow under yaw, the new one is clearly aimed to create as little of an obstacle to the airflow as possible. The support is as narrow as possible, and the thicker, bullet-like fairing follows the direction of airflow as it drops down over the bend of the rear wing's main plane before being kicked up.
14.14 **Williams FW36 – Front Wing**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Williams arrive in Monza knowing they already have quite a 'slippery' car having chosen a more efficient design than some of their counterparts this year (Sacrificing peak downforce). However Monza offers the teams a challenge like no other circuit and so the team arrive with a minor adjustment to their front wing.

![Front Wing Image]

The upper most flap of the stack has been cut back, reducing the net downforce the wing will produce, but still provide the innermost edge that assists in generating the Y250 vortex. The shorter chord of the upper flap will of course affect flow longitudinally, affecting things like tyre wake and flow around the sidepods. All of which should give a small decrease in drag.
Note: The drivers opted for the fuller (regular) flaps for qualifying/race day
14.15  **VIDEO – MERCEDES TECH OVERVIEW WITH CRAIG SCARBOROUGH**

[by Craig Scarborough from The Racer’s Edge]
The Mercedes team presented the W05 with a new rear wing in Spa, reducing the level of downforce that could be achieved but perhaps more importantly reducing the drag too. Monza provides the teams with a unique challenge, with the longer straights putting even more emphasis on drag reduction. With this in mind Mercedes have arrived with a similar wing to the one they used in Spa, however it does feature several subtle differences.

The Mainplane has been flattened out, reducing the wings overall angle of attack, whilst the length of the mainplane is also reduced (note the distance from the edge of the endplate, (below) places the mainplane much further back than usual).
This reduction in the mainplanes length means that the team have also had to re-design their support pylons, with more substantial appendages in use, arc-ing back to reach the mainplane at their uppermost point.
The upper flap must be shorter in chord length by regulation, but as we can see the two are quite close, meaning DRS will still have some effect should they need it. The upper flap also features larger V grooves and a curved lower edge which work in a 3 dimensional sense to achieve both maximum downforce for the least drag. (To appreciate the curvature of the wing and v grooves it's important to look at it 3 dimensionally).

The top flaps outer edges have reverted to their regular straight edge, rather than the curved ones used in Spa as drag reduction is also being taken care of more centrally. The loss of AoA also puts less emphasis on the louvres placed in the endplate with their number reduced from 5 to 4.

The team have also removed their Y100 Winglet / Monkey Seat as with the rear wing sporting a shallower angle of attack it doesn't necessitate the winglet to overcome the attachment issues at low speed.

Having removed the upper Gurney Trim from their wing in Spa and in an effort to cut drag further, both drivers are trialling the wing with and without the gurney before qualifying. The gurney is used as a fairly blunt method of increasing downforce/balance but comes at the cost
of increased drag, obviously at Monza it would be desirable to run without one but the drivers may prefer the extra balance in the slow speed corners.
The teams approach is outwardly more complex than some of its rivals with the team clearly using more angle of attack, thus incurring more drag and needing to find other design cues to rectify it. However the team are still right at the top of the speed traps, making it clear that the powerunit is having to overcome some of this deficit.
Mercedes arrive at Monza clearly ahead of their counterparts, this hasn't stopped the team from introducing new components though, with a change made to their floor just ahead of the rear wheel for Monza.
It's not something we haven't seen before with the design reminiscent of what Red Bull & McLaren adopted earlier in the season. As we know the area is critical to diffuser performance as airflow managed by these slots can increase the performance envelope of the diffuser.

NB: Tyre squirt is airflow that is laterally injected into the diffusers path by the rotation of the tyre, robbing the diffuser of performance. The area isn't subject to FIA load tests, so one can surmise that the dog legged design offers a favorable advantage in terms of flexing, when compared to a straight forward slot.

Furthermore, as this is something introduced by Red Bull, one has to think to the past to understand what advantage they are trying to recoup. If I look at how the dog-legged slots are designed I would also have to consider a design by Red Bull that was banned amid controversy in 2012. The dog legged slot allows for a more expansive hole ahead of the rear wheel (raised vertically), whilst the slot is presented much further forward, reducing the effect it has on the airflow passing through the hole. Which if compared to a slot that runs along the Y axis start to finish, the net effect will be lowered by the exposure at the periphery.
Worth noting is that although 3 teams now run this dog-leg design their interpretation will all vary, owing to other airflow structures being built in the area.

We must also consider that with the recent loss of FRIC means the car now behaves slightly differently at higher speeds, as FRIC was being used to regulate the ride height and therefore the rake and attitude of the diffuser. Adjusting the aerodynamic behavior of the floor is just another way of getting the optimum from the overall package.

Above is a good shot of the teams more simple tyre squirt slot that was in use before Monza
14.18 **MERCEDES W05 – WING MIRROR MOUNTS & COCKPIT FIN**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Mercedes arrive at Monza clearly ahead of their counterparts, this hasn't stopped the team from introducing new components though, with a change made to their wing mirror mounts and the cockpit fin that sits alongside.

The new mirror stalks are mounted on the side of the cockpit when compared with their older design (below) that was mounted on the top edge.
This means that the stalk is shaped to interact with the fin placed alongside it which is also reshaped. Previously the fin was triangular whilst the new fin is more of a rhomboid shape, this will of course have an effect on how it reacts with the stalk and the type of vortices that are shed.

The appendages that proliferate the area around the sidepods leading edge are critical to the behavior of the sidepod, determining how the sidepod reacts and at what speed. It's therefore altogether plausible that these changes could be Monza specific, with a premium placed on drag reduction and top speed, meaning this new configuration is able to delay separation/ reduce boundary layer build up at the tail end of the sidepod.
Above: The new mirror stalk is mounted on the side of the cockpit, with the fin placed just underneath it.
Above: The old mirror stalk is mounted on top of the cockpit entry, leaving the fin to work in isolation
14.19  **MERCEDES TWEAKS WINGS AND FLOORS**

14.20 **TORO ROSSO STR9 - FRONT WING**


Toro Rosso tried two different front wings in Italy. That shown in the inset was only tested on Friday and the team ended up using that shown in the main drawing. Apart from the endplate and main plane, the two solutions were very different. The chosen solution has wider upper flaps (1 - compare to 2) with a small, middle turning vane, and without the second upper flap section. It also has different flaps (3), with two elements instead of one, and with a long slot.
14.21 **TORO ROSSO STR9**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Toro Rosso arrive in Monza making some light revisions to the STR9 in order to further reduce drag, as their package is already relatively quick in a straight line, so it's no wonder they aren't introducing radical updates.

The team return to a front wing design last used in Austria, featuring a larger cascade element. Where it does differ in design however is the upper flap, which has been reduced in height (marked in yellow). This reduction in flap area will of course come at the loss of some downforce but this will also reduce the drag created too.

At the rear of the car the team have decided to abandon the use of endplate strakes, which will undoubtedly have an effect on the airflow structures work(ed) around it. The net gain will be a reduction in drag, however it will come at the loss of some downforce/balance.
14.22 **FORCE INDIA VJM07 – SHORTER CHORDS**


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**Force India plays shorter chords**

*Force India shortened the chord of the main plane of its rear wing to suit the low-downdforce demands of Monza.*

The yellow section and the dotted line indicate where the normal-specification wing is.

If you have a very long-chord main plane and a short flap, the centre of pressure isn't that far rearward on the wing. You are trying to get leverage from the rear onto the wheels and the centre of pressure dictates that leverage. So by shortening the main plane, you push the centre of pressure back a bit. It reduces the amount of downforce you are creating, and therefore the drag, but because you are increasing the leverage to the wheels, you don't get the same reduction in force on them.

Force India also tried to run without the louvres, which are there to minimise the draggy vortex created by the pressure differentials. But the team eventually opted to run them in the race.
14.23 **SAUBER C33 – REAR WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Saubers season has been less than ideal with the C33 not performing as the team had planned, however with Monza offering a unique challenge the team arrive with a new Rear Wing. Those that keep a keen eye on the technical details will know that although the team bring a low downforce wing to Monza, it's not usually full of design intricacy.

The wing presented here is very similar to the one used over the last couple of years although the endplates feature 2 drag reducing louvres in each one.
14.24 **CATERHAM CT05 – FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Caterham introduced a raft of upgrades for the Belgian GP (New Nose, engine cover / cooling & rear wing endplate strakes) but always the pace of development in Formula One is relentless, so for Monza the team also looked at making changes to their front wing.

As we can see in the main image the upper flaps height was reduced significantly, which results in less peak downforce. This will of course provide less drag across the length of the car, with less components seeing their airflow manipulated. The team have run both this and their regular wing (inset) throughout the Free Practice sessions in order to assess which gives the best balance.
14.25 **William FW36 – Rear Wing**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

The FW36 has been pretty quick all year, of course having the Mercedes powerunit has been a massive benefit to them but you cannot underestimate the job they've done aerodynamically. The FW36 is an efficient car, not strewn with aero components that force the airflow. This methodology does put more of an emphasis on mechanical grip and is likely the reason they struggled with tyre wear early on. Once they had a good handle on that they made much larger strides to the front of the pack.

The long straights / high full throttle time of Monza poses an even greater challenge, with the team opting (just as others have) to run an extremely skinny rear wing. The low angle of attack will undoubtedly result in less drag, making their car even more potent on the straights. The centre section of the wing is ever so slightly cambered around the more circular centre V groove, used to further reduce drag. Endplate louvres on such low angle of attack wings are either reduced in number or eradicated totally, their use afterall is to minimize the tip vortices generated by the two pressure gradients meeting. In the case of Williams they are down to just one louvre.
The use of the Y100 winglet / monkey seat is also eradicated for Monza as it's primary use is to connect the airflow structures, making for a more efficient rear wing at lower speed (aiding in attachment). Without the angle of attack the rear wing doesn't need assistance from a Y100 winglet in order to operate at its optimum.
14.26  **LOTUS E22 - TRIM TINY REAR WING FOR TOP SPEED**

[by Steven De Groote from http://www.f1technical.net]

Lotus were seen racing at Monza with the smallest rear wing of any car. The team created a Monza-only rear wing, another alteration of the already fairly skinny rear wing seen at Spa-Francorchamps. The wing retains the V-shape in the middle of the wing, but different to most wings, the Monza spec does not extend to the maximum allowed height. Instead the upper flap is trimmed down, before a removable gurney flap was added. The nature of the wing also allowed the team to remove any remaining louvres in the endplates.

Along with these changes, the rear wing also features a single, central support pylon that links to a bridge over the exhaust pipe. It remains to be seen whether this change is permanent, but it's interesting to see the team move away from their asymmetric pylon that connects to the car left of the exhaust pipe towards a commonly seen layout. Note however that the E22 continued
to features asymmetric sidepod outlets, the left hand side being much larger than the right to be able to cool the intercooler that sits low down in the left sidepod.

In the end though, it didn't matter much, as once again neither of the Lotus drivers came close to scoring any points. I understand that part of Lotus' lack of top end performance is due to their engine cooling setup, having less capacity and therefore the team's inability to exploit their Renault engine fully. Additionally, cutting rear wing is one thing, but making it this small also virtually eliminates all advantage you can get from DRS, making overtaking equally impossible.
14.27 LOTUS E22 – REAR END CHANGES

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Lotus will clearly be disappointed by their 2014 campaign, the E22 has failed to live up to expectations whilst the Renault powerunit issues have done little to help.

Like the rest of the field the team have decided to run with a very low downforce rear wing, to enable a higher top speed, owing to the drag reduction this creates.

Meanwhile the team have (for Monza at least) opted to change from their asymmetric pylon and exhaust layout for a more conventional centre-line approach. The pylon (Y-Lon) comes down and wraps around the exhaust, which should also aid in the extraction of airflow from the bodywork, with exhaust pulling on the airflow that radiates from the pylon surround.
The cooling bodywork remains asymmetric however, with the left hand sidepod home to more of the powerunit's ancillary components than the right.
14.28 **FEEDING FUEL TO THE HEART OF THE MATTER**

(by Craig Scarborough from [http://www.autosport.com/f1](http://www.autosport.com/f1))

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**On such a high-speed circuit as Monza, fuel efficiency is critical. Direct injection was legalised as part of the changes to engine rules in 2014. CRAIG SCARBOROUGH explains how it works**

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From the many challenges presented by the new 1.6-litre turbocharged V6 engines, one of the toughest has been the switch to injecting the fuel directly into the combustion chamber. This has been permitted because of the premium placed on fuel efficiency by the 100kg-per-race limit.

F1 cars have run fuel injection for decades, from the mechanical systems first used to the advent of electronic systems during the last turbo era. Both of these early systems placed the injector outside the engine, either directed into the inlet tract from the side or, latterly, from above.

While indirect injection gives the fuel and air a chance to mix before entering the combustion chamber, the fuel/air mix has a long path into the engine. So it could be that it doesn’t go directly down the inlet tract, or end up in the right place in the combustion chamber.

With direct injection, the fuel injector’s spray pattern and position can be tailored for better combustion and throttle response. This increased precision of the fuel delivery into the cylinder aids fuel economy.

To make direct injection work, very different fuel-injector types and fuel pumps are required. Luckily, each of the three Formula 1 engine manufacturers has road-car development programmes to fall back on, where direct injection is common. With early input from the road-car divisions, and with support from their electronics partners, bespoke direct-injection systems have been developed.

The first hurdle is getting the injectors to work at the very high fuel pressures required. F1 allows a maximum fuel pressure of 500 bar, which is 7251psi! As 500-bar fuel injectors are not available off the shelf, they have had to be developed to suit each engine in order to obtain the correct spray patterns for the best combustion.

Along with the injectors, the engines also require a fuel-pump system capable of delivering the 500 bar. With the old V8 engines, the fuel system consisted of low-pressure pumps to gather the fuel into a collector that feeds a high-pressure fuel pump mounted inside the tank. This, in turn, fed the fuel injectors at a mere 100 bar.

Now, a similar low-pressure pump delivers the fuel through the FIA fuel-flow meter, then onto the high-pressure pumps mounted on top of the cylinder heads. To reach such high pressures, they are mechanical pumps and are driven off of the camshafts. This positioning keeps the high-pressure fuel lines as short as possible.

The fuel lines are most likely integrated into the cylinder heads themselves, rather than external hoses. As the fuel has been pressurised to such a high level, teams may require a fuel cooler to reduce the temperature of the compressed fuel before reaching the injectors. These pumps are tiny, highly stressed and highly accurate.

Although the injectors and pumps are bespoke for their specific engine, as part of the homologation process to be allowed for use in F1 they need to be commercially available.

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See sketch next page.
15. **ROUND 14/19 – SINGAPORE**

15.1 **MERCEDES W05 - Y100 WINGLET**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

As we know most of the performance accrued by Mercedes against their rivals this season comes from their powerunit. However the amount of work done of the aero side should not be underestimated either with some very decent concepts in play. It seems more than perhaps most, Mercedes have focused their efforts on using the waste energy created by the exhaust plume as a further performance advantage. Over the past few seasons the use of exhaust blowing has primarily been aimed at sealing the edges of the diffuser, reducing the impact of tyre squirt and allowing the teams to run with aggressive rake angles. The placement of the exhaust along the cars centreline looked to reduce its impact but the teams can't unlearn what they know, in this case that the exhaust plume can offer a source of immense energy. The use of a turbocharger whilst connected to an MGU-H also quells the ferocity of energy dispatched by the exhaust, but nonetheless it's still something that can be used to levy an advantage.

Furthermore the loss of the beam wing for 2014 means that the teams have had to think a little laterally in terms of achieving aero structures that bind together to increase downforce. The aim of the game being that the diffuser and rear wing work together to increase downforce for less drag.

Mercedes have already made several changes to their Y100 Winglet / Monkey Seat throughout 2014 (Barcelona, Monaco, Spa) alluding to development in the area and also how they treat specific track characteristics inline with their rear wing design.

The team have once again made a small change to their design for Singapore changing the guide blade that sits astride the upper extension of their ladder winglet.
As we can see from the older configuration (inset) the upper blade has been replaced by twin blades, this alteration may seem small but the way in which it manipulates the airflow will of course have an impact on performance. The inclusion of the secondary blade is likely done to delay the point at which the exhaust plume (and surrounding airflow it guides) interacts with the upper section of the top flap, meaning the team can run more angle of attack without flow separating, increasing downforce and reducing drag.
15.2 **MERCEDES W05 – GEAR RATIO CHANGE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

If you've been hiding under a rock this season you won't have realised that Mercedes have barely used their 8th gear. Unlike previous seasons the 2014 regulations only permit ratio's to be changed once in a season (a joker as we refer to it) in order to save costs. Mercedes were the only team to run an exceptionally long 8th gear, meaning that their drivers rarely used 8th, and in all honesty its effectiveness would be stifled by a large power drop off when it was used anyway. The idea of course was to spread the immense torque generated by the 2014 powerunits, reducing the chance of wheelspin whilst retaining the optimum gears throughout the corners.

In the last few races other teams have played their own jokers, having had time to maximise the powerunit to their chassis package, and in keeping with the circuit characteristics remaining this season. With this in mind both Mercedes drivers played their joker this weekend in Singapore (below an excerpt from document no4) to bring them inline with their rivals, whilst looking to improve their own performance.

A seal was broken on the gearbox of car number 44, driver Lewis Hamilton, and car number 06, driver Nico Rosberg, in order to replace all change gear ratio pairs and associated dog rings for re-nominated ones.

This was done in accordance with Article 9.6.2 of the 2014 Formula One Technical Regulations.

Furthermore in the document we can see that the team broke the seal on the powerunit to replace the driveline for the MGU-K. This is not particularly newsworthy as teams do this from
time to time (all Mercedes powered cars did so in Singapore) but I'd suggest the change in the works teams case was made inline with their gear ratio change. The reason being is that the MGU-K is geared, allowing for a smaller more efficient unit, changes in the gear ratios however will also mean that the MGU-K will be harvesting and dispensing energy at different rates than usual. Mercedes AMG HPP therefore may have been working with the team on this change and decided to beef something up for reliability whilst playing their joker, but also offer the new solution to their customers too.

A seal was broken on the ICE numbers 3 and 4 of car number 44, driver Lewis Hamilton, in order to replace the MGU-K driveline for a new one.

This was done in accordance with Appendix 2, item n° 12, of the 2014 Formula One Technical Regulations.

A seal was broken on the ICE numbers 3 and 4 of car number 06, driver Nico Rosberg, in order to replace the MGU-K driveline for a new one.

This was done in accordance with Appendix 2, item n° 12, of the 2014 Formula One Technical Regulations.
In Singapore Red Bull introduced yet another new nose design, illustrating just how hard they are pushing to keep Daniel Riccardo in championship contention with the two Mercedes drivers. On Friday at Marina Bay the team ran the previous Hungary-spec nose (inset), but they then switched to the one shown in the main drawing, featuring more pronounced lower bulges (red arrows) to help increase downforce. It’s their fifth nose iteration of 2014. The first change was in Spain for a revised camera position, and that was followed by new solutions in Monaco, Hungary, Belgium and now Singapore. As the alterations were to bodywork and not structural, there was no need for fresh crash tests.
In Singapore McLaren introduced a quite unique solution at the top of the diffuser area at the rear of the car. An additional small flap (red arrow) was added under the two bodied suspension elements in order to increase the downforce level and help the efficiency of the diffuser.
15.5 **MCLAREN MP4-29 - Y100 LADDER WINGLET CHANGE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

In a outwardly minor alteration in Singapore, McLaren have adjusted the ladder winglets that sit astride the rear crash structure (above). Responsible for upwashing the airflow in the region and creating a centralized connection between the diffuser, exhaust, main Y100 winglet (Monkey Seat) and rear wing any changes clearly has impact on several flow structures. We must therefore bear in mind that the team return to the use of both wishbone wings for Singapore, having just used the lower ones at the last few races; whilst they changed the central portion of the diffuser in Spa.
As we can see from their previous Y100 ladder winglet (above) the upper section is designed very differently, not only do we now find an extra section at it's base with which to release airflow, we also see the zircotec painted (silver tips) have been removed. This will clearly have an impact on the trajectory of the exhaust plume, with it most likely having a more spanwise effect on the upper wing surfaces.
15.6 **WILLIAMS FW36 – FRONT & REAR BRAKE DUCTS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Williams have been quietly going about their business this season, the FW36 not smattered with updates at every GP as an attempt to increase performance. I’d like to classify their development as economic, finding performance from their base setup at each GP, whilst smaller updates bridge the gap. The team arrived in Singapore knowing that teams like Red Bull would take a demonstrable leap ahead of them owing to their more downforce laden chassis. Finding performance therefore for Williams has come from the team trying different approaches with their brake ducts, which of course will not only affect temperatures directly but also change how the tyre phases on longer stints.

At the front of the car the team arrived with an enclosed caketin arrangement (above), whereas the team have run with an open arrangement prior to this (below), with just a crossover duct moving airflow from the scoop and blowing it out through the wheel.
The new configuration is looking to retain more temperature for use by the brakes, whilst lowering the core temperature of the tyre.
At the rear of the car the caketin remains largely untouched but the team reverted/trialed a solution used earlier in the season with a duct (above, image AMuS) replaced by an airflow control winglet (below, image AMuS).
This would reduce the amount of cooling done within the caketin, raising the core temperature of the tyre, in an attempt to leverage more mechanical performance from the tyre. The problem with this however is that it will also raise the degradation level of the tyre on a longer stint.

As with all decisions of this nature it's a performance trade off and something that can also suit one driver more than the other. Meanwhile the lap time delta between the two compounds taken to Singapore is larger than anticipated and so decisions of this nature then become even more critical for race pace.
15.7 **SAUBER C33 - REVISED FRONT WING**


Sauber have introduced quite a big update package in Singapore, including a new engine cover, more similar to Ferrari's, with a wider oval cooling exit in its central section. Also new is the front wing shown in this comparison drawing. In the main picture we can see the new endplate with a longer outer fin, while the inset shows the previous shorter solution. The flaps have also been revised in order to increase downforce.
15.8 **SAUBER C33 – FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Sauber made their last large upgrades at Barcelona, one of which was a change in front wing philosophy that saw the team introduce a new cascade element and an outboard endplate canard. For the high downforce street circuit of Singapore we see that the team will once again make a change in this area (See image below, inset shows the older configuration).

The team have lengthened the canard which will change the way in which the vortex it sheds is formed but also how that affects the surrounding airflow. This should have a marked effect on the flow around and over the front tyre, with the canard creating a pressure gradient on the outside of the endplate that encourages flow from both the cascade to flow upward and also pull the airflow through the rearward endplate slot. Of course this has a downstream effect, changing the front tyres wake and the impact this has on the floor.
15.9  **SAUBER C33 - SIDEPODS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Sauber have already made attempts at rectifying their performance disadvantage this season but for Singapore we find that the team have once more turned their attention to the sidepod bodywork. This is the 3rd major iteration of their sidepods, with a change made in Barcelona that increased the size of the inlet to accommodate more cooling. The changes didn't stop there though with the bodywork size and shape adjusted, catering for the way in which the airflow moved downstream, into the coke bottle region.

The new bodywork, retains the inlet size run since Barcelona but looks to trade off some of the cooling requirements with changes at the rear of the car. This comes off the back of Sauber taking a step the two other Ferrari powered teams took in Spa when they followed suit in Italy covering the exhausts primaries. The result of which is a retention of heat within the exhaust itself which increases the potential of the powerunit. (Image @ScarbsF1)
An increase in length of the sidepod, will help to retain the aspect ratio of the upper surface, as the upper cooling outlets increase in size encroaches on the sidepods bodywork. The changes have also ushered in further curtailment of bodywork paint, with the rearward part of the engine cover now left bare. This will advantages in terms of heat displacement and also marginally save weight. (Many teams have moved to an elongated sidepod exit this season with the placement, shape and orientation critical to the performance of the floor, diffuser and rear wing, as all these structures can be compromised by it).

The adjustment of the lower outlets means the upper outlet has been increased dramatically in size (above, with the inset showing their Monza specification). The team have also re-introduced their monkey seat (Y100 winglet) which sits just above the exhaust, looking to increase the upwash effect in the region (assisting both the diffuser & rear wing). Furthermore the fins that run either side of the crash structure (in the Y100 region) are now two piece elements either side, making them much taller; which will of course change the flow characteristics/upwash in the cars centreline.
15.10  **SAUBER C33 – TIDY ENGINE COVER**


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**Sauber’s tidy engine cover**

Sauber introduced an upgrade package in Singapore, including a new engine cover, modified floor and a tweaked front wing.

The engine cover has been tidied up. Everyone has been going in that direction, trying to tidy everything up as they get a better understanding of the cooling demands. It’s very complicated in that area with the air intake feeding the turbo and then the pressure charge going to the intercooler, and now teams are able to squeeze everything just a little bit more.

It’s a detail change that should also give better airflow to the rear wing, making it more efficient. It’s only a small gain. It all helps to increase the efficiency of the car, but you are talking hundredths of a second in that area.

The floor has also been changed to include the Mercedes-style slot in front of the rear wheels. In addition, there has been a change to the horizontal flick-up on the outside of the front-wing endplate to help to improve the airflow around the front wheels.
Singapore comes off the back of the stand out aero track of the season, with Monza providing a backdrop to the only truly low downforce package. Before that we had Spa which although it's classified as a medium downforce circuit it puts a massive onus on drag reduction, owing to the long straights encountered by the drivers. This gives the teams a window of opportunity for which to concentrate their efforts on the closing rounds which are more skewed toward downforce.

With this in mind Force India who've trialled several new pieces over the last few races but abandoned them without racing them arrive with a new Front Wing. The endplate that was previously split into two sections (above) is now a re-designed singular element, changing how and when the inner and outer flow structures meet. Like many of its rivals the team have also invested some effort into adding a canard element (below). These canards are all designed around the concepts of each of the teams current front wing ethos and Force India are no different. Placed on the upper front edge, the canard's purpose is to help draw air over and
around the front tyre by creating a vortice and pressure difference that entices the airflow around the endplate.

Above: Image from AMuS
15.12 **FORCE INDIA VJM07 – DIFFUSER & REAR BREAK DUCT WINGLE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Force India have introduced large upgrade packages at several key stages of the season, but retained a constant flow of parts throughout the season too. For the high downforce configuration of Singapore the team have introduced some updates at the rear of the car to bring extra performance.

These updates come in the form of new rear brake ducts and a new diffuser, which have been introduced in tandem as both provide performance that can't work in isolation.

The diffuser features several key changes:

1. The inner most strakes have been set slightly back from the tip of the diffuser and now feature a very Red Bull-esque slot in the bottom section.
2. The secondary strakes have also been set back from the tip, allowing the upper surface to be straightened, whilst a section has been cut out from the trailing edge.
3. The 3rd strake has been set back much further, whilst the fourth strake has been deleted.
4. The diffusers periphery has been shaped differently too, to counter the loss of the 4th strake. Whilst the perforated gurneys outer section has also been increased slightly in size.

The team have also made a change to their rear brake duct winglets (below, whilst their old ones can be seen in the image above), inline with the changes made to the diffuser as both have an impact on the tyres wake, meaning a change in diffuser ethos must also be met with a change to these winglets.
The F1-Forecast Technical Files
http://www.f1-forecast.com

Above: Image via @ScarbsF1
15.13 **STEERING WHEEL DATA DISPLAYS - LARGE VERSUS SMALL**


With many pit-to-car radio messages banned from this weekend's Singapore round onwards, drivers will be relying more on their in-car data displays - and those with older, smaller screens could find themselves at a distinct disadvantage. For 2014 the teams had the option of increasing the size of the mandatory display screen in the cockpit (some, like Red Bull, house the screen in the cockpit fascia, others in the steering wheel). Five teams - Red Bull, Williams, Lotus, Force India and Caterham - chose to retain the 2013 size (shown left). The others moved to a much bigger screen (shown right), 54mm high and 95mm wide. With the complex management of the 2014 power units, there is a lot of information for drivers to digest and the larger screen allows for more data to be displayed without the need to scroll between pages.
15.14  **RED BULL RB10 – CHANGERS FOR SINGAPORE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Having come off the back of what Red Bull would consider two very low downforce circuits the team arrived in Singapore, in familiar territory, looking to capitalise on their strengths, with the RB10 still regarded as the best chassis in the field.

Having used extremely skinny rear wings for both Spa and Monza the team returned to a similar specification last used in Hungary, with a high angle of attack also warranting their upper Y100 winglet / Monkey Seat.
At the front of the car the team made further changes to the RB10's nose, increasing the depth of the 'pelican' underbelly (see green line added in the inset). The pelican had been deleted for the last few races as at higher speeds it overwhelms the region, stagnating flow and causing too much detachment. At lower speed/high downforce circuits the 'pelican' actually speeds up the airflow as it creates its own low pressure region in behind the region, whilst keeping flow attached to the underside of the nose is critical to the noses upper surface too, owing to their use of a 'S' duct (below).
The heat in Singapore can also play havoc with the powerunits performance and so Red Bull ran with a revised cooling gill arrangement on the top of their right hand side pods. The chevron shaped gills will of course release airflow in a different manner to their straight edged counterparts and so clearly Red Bull have found an advantage from doing so (Likely that their shaping energizes the slower moving hot airflow).
15.15 **HONDA ARE BACK**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

Using the Japanese GP as a springboard Honda have released the first image of their 2015 Powerunit.

So what can we learn from the image provided by Honda? Well, probably very little, as with the other engine manufacturers did prior to 2014 I don't see any reason for Honda to supply an actual image of their PU ahead of schedule. This would simply provide their competitors with a glimpse, all be it small but nevertheless insightful as to their direction.

As I posted the image up on my Twitter timeline first this morning the initial reaction was one of "That looks like the Mercedes PU". Coming to the party a year late has given Honda a glimpse of what everyone else has done before them and so they can use that and place it in their own Powerunits architecture. Furthermore, as the Powerunits have specific dimensions mandated by the FIA especially in terms of their mounting (this was done initially so that teams could switch easily from one supplier to another) outwardly the PU's all look very similar.
IF the image were to be representative we could conclude that they may have chosen to run the split Turbo configuration used by Mercedes this season, with the Turbine at the rear and compressor at the front of the ICE with the MGU-H running between the V. However I'd suggest that the design is more of a halfway house between the Mercedes and Ferrari, as the former place the Turbo much lower in the V. The height of the turbo in relation to the V may indicate, like Ferrari that the compressor lies within the V putting less emphasis on the strength of the shaft that connects the two, and the design of the MGU-H that resides between them.

The airbox snorkel also makes up the ballistic shielding for the turbo, hiding where it joins to the compressor and the inlet layout from prying eyes. Whilst in a similar vein to Renault's mockup the exhausts are shown encased in a carbon shroud closely aligned to the exterior of the ICE. No wastegate(s) are visible either just as we saw with the other mockups.

As we know Powerunit architecture is not only important in terms of producing power but also have ramifications to the packaging of ancillary components, whilst aero design must also be considered. It's therefore of no surprise that Honda have decided to base their operations in Milton Keynes, not far from the team they'll supply, allowing ease of communication on the project. Honda's arrival a year later into a new regulation run can be seen as both a good and bad thing, with the other 3 manufacturers having huge quantities of real world data to work with. Meanwhile it has afforded Honda a glimpse into the direction that would serve them best, with a fresh sheet of paper to design their Powerunit whilst the rest may only change 48% of theirs for 2015.

I look forward to the re-emergence of Honda within F1 and hope that the successful partnership they once shared with McLaren can re-ignite their challenge too.
A change in the sporting regulations in regard to wind tunnel facilities for 2015 that may seem irrelevant from the outset may actually have some hefty ramifications. The change in question was added to article 1.5:

"Each Team may nominate only one wind tunnel for use in any one twelve month period. The first nomination must be made on or before 1 January 2015 and no re-nominations may be made for at least 12 months. The FIA will consider, at its absolute discretion, earlier nominations if a wind tunnel already nominated by a team suffers a long term failure."

As usual the FIA added the caveat under the illusion of cost cutting, and although their intentions are sound (ie prohibiting multi tunnel use by the larger teams) it does handicap the mid-low end teams. Since 2009 when track testing was curtailed, the teams have turned to simulation techniques and the wind tunnel as methods of improving performance, before then correlating the information at the track. The changes also meant that 60% scaling became the new upper limit, much to the dissatisfaction of Honda, who'd just spent a considerable chunk of money upgrading their facility at Brackley to utilize a full scale model. Honda had ploughed huge
resource into their 2009 challenger looking at a vast array of options not only in CFD but also
modelling numerous iterations of the ill fated RA-109 (nee BGP-001). I've looked at this on
various occasions so I won't go too deeply into it again here, but suffice to say their tunnel at
Brackley and in Japan was being worked overtime, all adding up to ££££'s down the drain?...

Honda's exit from the sport not only came at the time of the economic downturn, it was their
vast (blackhole like) spending on their F1 programme that caught the attention of the board.
Allied to this was the exit of their closest rival Toyota, who also used the economic downturn as
an opportunity to get out of a sport that was putting a financial strain on the main company.
Don't think that's the end of eithers involvement though, as both have continued to have a
much smaller team work on and develop concepts for use in Formula One should one day a
return become financially viable.

Honda’s decisions also impacted the early life of the Mercedes team too with the team using
tooling and methods for a 50% scale wind tunnel. Mercedes bore the cost of replacing these in
2012 and have since started to reap the rewards of operating at the larger scale. 10% may not
seem like much but when races are won by tenths of a second and qualifying relys on margins of
much less, every bit of performance counts.

Turning our attention to the two giants of the sport that have languished behind their rivals
since 07/08: Ferrari & McLaren, we must consider their processes as a catalyst to this. The
transition from real world testing to simulated improvement has hurt their progress and seen
others who embraced the change take a stand against their legacies. Red Bull is the most
obvious candidate having taken both drivers and constructors titles for the last 4 years, however
I'd suggest Force India have also taken to the change well.

Of course having the equipment is only one factor in achieving extra performance, having the
the right people using it is also vital and perhaps where Ferrari & McLaren have become
sleeping giants. They may not openly admit it but the ramifications of Spygate in 2007 may also
have changed not only the way the teams worked but also the way they hired/vetted staff going
forward. Furthermore it put everyone on a shorter leash with the FIA scrutinizing things much
closer. Having failed to see how important the transition from track to model testing both teams
have used the facilities in Cologne owned by Toyota, some times to correlate with their own
tunnels and at others to complete the bulk of their work. The problem with long term use of a
tunnel "off site" is that people begin to work autonomously, needing constant attention from
management.

The facility at Cologne is renowned for being cutting edge providing PIV in the tunnel, whilst also
providing customers a platform with which to operate (workshop space, measuring and milling
machines, a clean environment (incl dust extraction) for carbon layup etc). However, it is not
the teams, therefore they cannot operate comfortably, however much they try to make it like
home. At one time or another several other teams have used the facilities to validate their findings in their own tunnel in a more sophisticated environment or correlate data from their own tunnel (Williams, Force India and recently Caterham doing some work on their 2015 challenger).

Going forward this will no longer be an option with all the teams having to nominate their chosen tunnel for a whole year. Force India have taken the bold step of moving their operations to Cologne, renting one of the tunnels Toyota make available. This will allow the team the option of constructing a new tunnel as the one they acquired when the team purchased Jordan is now somewhat outdated (30% tunnel, using a 50% model, which goes to show what you can achieve by literally thinking/working outside the box), or if it's more cost effective retain the use of Toyota's. As you'll see below I've constructed a rough list of what the teams currently use and if they are projected to change in 2015 they're in Italics

Mercedes - 60% - Brackley
Red Bull - 60% - Milton Keynes
Ferrari - 60% - Maranello
McLaren - 60% - Woking & Toyota Facility (Cologne)
Williams - 60% - Grove
Lotus - 60% - Enstone
Force India - 30% Tunnel with 50% model - Northants - Toyota 60% Facility (meaning they'll have to upscale their scale model production too)
Toro Rosso - 50% - Milton Keynes
Sauber - 60% - Hinwil
Marussia - 50% - McLaren (Woking)
Caterham - 50% (Williams, Grove) & 60% Toyota Facility (Cologne), testing their 2015 designs.

So on the face of it nothing much changes, however what it does do is stop correlation work with other tunnels, force McLaren to choose between their own tunnel or the one they rent at Cologne (and currently divide the on wind time hours between the two) and inhibits the lower teams choices in terms of where to work, as they don't have their own facilities. Caterham for example moved to Leafield to bring the team closer to the facilities they are using at Grove, unifying the two work forces but under new ownership they may have sought other options.

In reality it's difficult to ascertain whether the regulation change was infact done to affect costs, rather as I see it, it was done in order to stop the teams from using multiple tunnels which of course reduces costs but also further reduces the possibilities for smaller teams to improve by sourcing better facilities, thus keeping parity between those at the top and those at the bottom.
15.17 **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images from Singapore courtesy of Sutton Images.
16. ROUND 15/19 – JAPAN

16.1 VIDEO – F1 TECH OVERVIEW WITH CRAIG SCARBOROUGH

[by Craig Scarborough from The Racer’s Edge]
16.2 **MERCEDES W05 - SUZUKA AERO UPGRADES**


For Japan the Mercedes' sidepods were totally revised (right-hand drawing - previous version on left), starting from the vertical turning vanes (1) on the outer front corner. These are attached in a different way to the stepped bottom area (2), which is also modified with a long horizontal slot (3). This area manages the airflow going under the floor and around the sides of the car, and is vitally important for the consistency of under-body downforce. The small fin (4) under the rear-view mirror has also been altered.

For Japan, the modifications to the front of the Mercedes' sidepods were accompanied by changes at their rear, with a quite significant reduction in size in the coke-bottle area of the car (1), utilising the space gained by the removal of the FRIC suspension system, which was effectively banned earlier in the season. Mercedes have also modified the floor cut-out in front of the rear tyres (2 and inset), following the shape introduced earlier in the year by Red Bull.
16.3 **MERCEDES W05 – DETACHED FLOOR SCROLL**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

As we know development in F1 is relentless and so Mercedes continue to tune the W05 based on general R&D and circuit characteristics. For Suzuka the team have introduced a detached floor scroll (above), it's something we have seen other teams use with Lotus and Red Bull being the most notable examples.

The scrolls in this region are used to control how both the airflow that comes around the front face of the sidepod then migrates around the floor surface to the rear of the car and how the front tyres wake impinges upon this and the performance of the underfloor/diffuser.

It's easy to only think of the wakes influence with the tyre facing straight ahead but we must remember that it's when the car is cornering that downforce is at a premium. This means that the wake is constantly evolving dependent on the cars attitude meaning you need components to work over a wide performance threshold. Much like the perforated gurneys used above the Diffuser the scroll allows a small quantity of airflow to be injected, effectively increasing the scrolls angle of attack and aspect ratio, making it more efficient over a wider speed range.
Meanwhile with two flow regimes rather than one, different vortices will be formed, changing how the airflow structures in the region operate. As usual, outwardly the change may seem minor but it's performance can have widesweeping ramifications up and downstream.

Above: In this image from Singapore we can see that the team have been using a singular scroll in the region.

The team also made a revision to their airflow conditioner, which is now mounted to the bargeboard rather than the floor.
16.4 **MERCEDES W05 – FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

As we know development in F1 is relentless and so Mercedes continue to tune the W05 based on general R&D and circuit characteristics. For Suzuka the team have made a minor change to the base of their 'r' cascade, incorporating a slot into the base (circled).

Reducing the length of the cascades base is clearly not possible, with it used to help in the turning of the airflow outward. Reducing its length may cause too much flex, either compromising its aero characteristics or causing it to fail, both of which could be detrimental to performance. Adding a slot retains rigidity but removes an element of obstruction it causes to the elements cited behind it. As we can see the team have already made maximum effort to shorten the main cascades connection with the mainplane it sits astride.
16.5 **MERCEDES W05 – COCKPIT COOLING SLOT**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

In a small change to the W05 we find that Mercedes have added a small cooling duct atop of the chassis, the slot/duct allows more airflow into the cockpit but may not just be for driver comfort. Since the start of the season the W05 has had driver cooling slot placed in the tip of the nosecone which provides a supply of fresh/cooled air into the cockpit.

Therefore we must assume that this new slot/duct serves not only as a method of providing additional cool air, but has also been added as a short term solution in relation to the failure saw in Singapore. Afterall Singapore is the most demanding circuit on the calender for the driver and so one would assume if extra cockpit cooling was required, it would have been tailored for that track.

The failure which prevented Nico Rosberg from partaking in the Singapore GP was thought to be caused by contamination of the steering column loom by the team. However with the team eager to allay any fears of a repeat of this, the slot may have been added to cool the region
before team members clean the loom. With a short being likely being caused by wire exposure (due to heat stress) coming into contact with cleaning fluid.
Mercedes have introduced a new diffuser for Suzuka which deletes one of the standout design considerations their previous one featured. Gone is the centralised 'U bend' which not only allowed access to the engines starter but also allowed airflow from the upper surface to permeate the diffusers airflow structure. It's a design feature that has since been assimilated by McLaren but now appears to be defunct in the eyes of Mercedes. They have returned to a more conventional boat tail centre section with a hinged flap, allowing access to the starter. Furthermore you'll note the team (like many of the others on the grid) have installed a row of small vortex generators on the transition between the plank and diffuser.
16.7 **Ferrari F14T – Front Wing**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The image above comes courtesy of @ferran figura who snapped this modified wing being run by Ferrari during Free Practice. As we can see not only has an additional adjuster been added (circled) the flap behind it has been cut away too. It seems that Ferrari may have been looking at developments for next season with this with the larger adjuster changing the main flap angle, whilst the inner adjuster (small circle) has been retained but now likely changes the upper/outer flap angle, which isn’t currently viable (Perhaps allowing the team to trim how the outer profiles work in unison with tyre deformation, fuel load etc throughout a race) or is simply a relic of the older design this is piggybacking.
16.8  **RED BULL RB10 - POWER UNIT CONFIGURATION**


Compared to that of the Mercedes, Red Bull's power unit layout is much more complicated. Behind the normal radiators (1) on each side of the car there are large air-to-air intercoolers (2) to lower the engine intake air temperature. The exhausts are quite different from those of Lotus, who also use a Renault power unit, and in fact look quite similar to the Mercedes', with very short pipes (3) to help keep as much temperature and energy as possible in the exhaust gasses in order to help the performance of the MGU-H. They also have a small exhaust (4) coming off the waste gate that goes into the top of the main, singular exhaust tail pipe mandated by the FIA in the 2014 regulations.
16.9  **WILLIAMS FW36 - REVISED ENGINE COVER**


Williams introduced a new engine cover for the Japanese round at Suzuka. It is just a little tighter and shorter - by around 5cm - than the previous version, in order to improve the airflow to the car's rear wing.
Williams pace this season has been fantastic but to keep that momentum going and keep up the fight with Ferrari the team know they must continue to make gains. With this in mind the team arrived in Japan with a new svelt engine cover. As we know the cooling configuration run by Williams is like no other with a rather large exit at the base of the engine cover, whilst another cover resides over the gearbox/suspension etc. The new cover retains its predecessors outline but is decreased in size, owing to the lower cooling demands of a circuit like Suzuka. This streamlining is further evident with the engine/gearbox mountings visible from the tightly wrapped bodywork, which look like blisters. (Circled below). As we can see the perforated gurney trim which runs around the periphery of the cooling exit has also been retained, aiding in the extraction of hot air.
16.11 **TORO ROSSO STR9 – NEW NOSE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Toro Rosso are continuing their development having arrived at Suzuka with a new nose, having followed their Red Bull counterpart in terms of the new design. Utilising a wedge & keel design that circumvents the dimensional requirements set out for the nose tip, the idea is to allow a better quality of airflow under the nose, which will of course increase the quality of flow rearward, toward the splitter and sidepod undercuts, improving flow to the rear of the car.

The front face of the nose tip will create a high pressure zone, allowing the airflow to accelerate around it into the swept back keel section as it looks for the lower pressure.

Like their big brother Red Bull, the team have also incorporated a U shaped cooling slot in the front face of the nose tip, whilst I don't have full evidence yet they may have also incorporated an 'S' duct, taking air from underneath the nose and assisting flow on the top surface.
Above: As a comparison here is Max Verstappen's maiden FP session using the older specification nose
16.12 Toro Rosso STR9 - Adds S-duct in new nose

[Toro Rosso have come to Japan with a new nose cone on their STR9, which notably also included an S-duct inspired by Red Bull Racing. The car's new nose is much thinner on the lower side, now featuring a short bulb at the very front to meet the regulations while minimizing the obstruction to airflow underneath the nose cone. The previous 'finger nose' was much thicker and was an essential part of the front crash structure, whereas the new one has its crash structure starting further back.

While the introduction of this nose cone was originally planned for the Singapore GP, the design is a remarkable effort, knowing that none of this development will be transferable onto next year's car, due to the modified regulations that aim to prevent these nose extensions.]

[by Steven De Groote from http://www.f1technical.net]
The S-duct on the other hand may very well provide the team with useful information for its 2015 development programme, as nothing in the rules prevents any such duct this year or the next. The S-duct, named for the shape of the duct inside the nose cone, bleeds some air off the boundary layer on the lower side of the nose and directs it to a vent on the upper side. In Toro Rosso's case, the vent is noticeable exactly behind the 'Cepsa' sponsorship logo.
16.13 **TORO ROSSO STR9 - Y100 WINGLETS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Toro Rosso are continuing their development having arrived at Suzuka with a new Y100 Winglet arrangement. The new twin winglet configuration is an ongoing development of those used in the past, with the new winglets looking to further harness the exhaust plume.
As we can see from the image above, when viewed from the side their design is 3 dimensional, rather than appearing flat when viewed from directly behind. The horseshoe design will manipulate the exhaust plume in a different way to how its predecessors did, perhaps with a more localized intent, driving the centreline performance of all the aero structures/components, lessening the drag penalty.

Although the use of exhaust gasses to drive aero is lessened in 2014 by the exhausts centreline placement and connection of the MGU-H to the Turbo, the teams are still looking to use any wasted energy. Furthermore the loss of the lower beam wing requires the teams to contrive other methods of creating flow structures that connect together to increase rear downforce.
As we can see in this great image captured by Sutton when the STR9 decided to lunch one of its Powerunits the exhaust plume is clearly being washed upward (upwash), which helps to connect the airflow structures being generated by the diffuser, floor, cooling outlets, brake duct fins, plethora of centrline winglets and rear wing.
Above: The Y100 Winglets run of the STR9 in Singapore
16.14 **TORO ROSSO STR9 - BARGEBOARDS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Having introduced their new nose design in Suzuka, the team also revised some additional elements that will make use of the extra mass flow under the nose.

![Image AMuS](image_url)

**Above: Image AMuS**

The bargeboards now feature two slots on the upper edge, much like we have seen on the Red Bull and Lotus in the past. The slots are added in order to change the flow characteristics of the component, with the additional/cleaner mass flow now entering under the nose, toward the splitter and then onward to the bargeboards needing extra treatment.
Above: STR's bargeboard from Singapore
16.15 **CATERHAM CT05 – FRONT WING**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

The image above shows Caterham's new front wing for Suzuka (Image: AMuS) is a variation on some of the concepts the team have already worked on but contains several new elements too. The separation of the mainplane is handled differently whilst the upper flap now becomes two separate flaps, having previously only split the flap so far along its length before. The reduction in width of the front wing from 1800mm to 1650mm for 2014 has meant that this year's front wings are designed with more aggressive outwardly turned elements, Caterham's new iteration is no different.

As I said the wing is not revolutionary but evolutionary, with the team actually returning to the cascade arrangement used earlier in the season, however you'll note an elongated horizontal blade now hangs off the endplate above the main cascade. The rearward blade is retained, albeit with a slightly revised design, whilst inboard of this the 'r' cascade has reverted to a singular element. Interestingly the team have followed many of the other teams by adding an outboard endplate canard, mounting it to the rear endplate (2 piece endplate design). The
canard creates a pressure gradient that entices airflow outbound, whilst shedding an elongated vortex that will marry with several of the airflow structures generated around it.

Above: The pre-Suzuka front wings
16.16 **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images from Suzuka courtesy of Sutton Images.
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TECHNICAL UPDATES – JAPAN – ROUND 15/19

The F1-Forecast Technical Files
http://www.f1-forecast.com
17. **ROUND 16/19 – RUSSIA**

17.1 **VIDEO – SCARBS ON SOTCHI – F1 TECH UPDATE**

[by Craig Scarborough from The Racer’s Edge]
17.2 **VIDEO – F1 CLOSED COCKPIT: WHAT THEY’LL LOOK LIKE**

[by Craig Scarborough from The Racer’s Edge]
17.3 VIDEO – MERCEDES F1 GEARBOX SECRETS REVEALED – SCARBS UPDATE

[by Craig Scarborough from The Racer’s Edge]
17.4  **MERCEDES W05 – CLEVER TWO PARTS GEARBOX EXPLAINED**


Mercedes’ clever two-part gearbox explained

Mercedes has been running a two-part gearbox all season. An F1 car is made up of three main components, a chassis (or survival cell), the engine and the gearbox and they are all structural members.

But to make a gearbox that is functional, a structural member and that can have the suspension mounted to it is quite difficult. So Mercedes has a small titanium ‘gearbox-carrier’, or cartridge, that goes inside a carbon fibre gearbox casing.

It’s difficult to build an efficient casing for the gearbox internals out of carbonfibre. You would usually put titanium bits into the carbon casing anyway. So Mercedes has a stiff gearbox case for the gearbox itself, which goes inside the carbon casing that has the suspension attached to it.

It’s a good design, with a good balance of weight to stiffness. This also allows changes to be made to suspension geometries without changing the gearbox, so it does give you a window of opportunity to develop that.

The clutch is also mounted on the engine itself rather than the gearbox, where the clutch had been moved to because of increasing loads. The 2014 lower-rpm engines mean that it is now possible to mount it on the engine again.
17.5 **MERCEDES W05 - NEW DIFFUSER**

First seen in Russia, this revised diffuser (main drawing - previous version inset) is the latest step in the aero update introduced by Mercedes at the last round in Japan. It differs from the previous version in the middle section, where they have closed off the narrow central channel (inset - red arrow). This channel had been on the car from the first race of the season and helped with the re-attachment of the airflow on the central part of the diffuser. To improve the top speed of a Formula One car the diffuser will stall at low ride heights on long straights. When the car then gets to the braking zone, the airflow needs to re-attach very quickly otherwise the car will become unstable under braking. In place of this channel Mercedes have added small vortex generators (main drawing - red arrow), as first introduced this year by Red Bull. These set up a rotation in the airflow, improving the airflow's energy levels, which then helps with the airflow re-attachment. In Sochi this diffuser was used with a medium-downforce rear wing configuration.
17.6 **MERCEDES W05 – REAR WING & Y100 WINGLET**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

Firstly I'll point out that the rear wing and Y100 winglet used by Mercedes (above) during qualifying and will be used for the race are not new, having previously been used the configuration at Spa.
As we can see from FP1 & 2 (above) the team initially setup with a much higher downforce configuration, likely anticipating a higher level of degradation of the tyres for the race. With tyre wear significantly lower at Sochi than expected and with Williams clearly being able to match them for pace the team opted to run with less downforce, which also means less drag. Sochi has been branded as a street circuit but in reality it's a purpose built 'Autodrome' around the ex-Olympic park, meaning its design allowed for two extensive straights (rather than being confined to an existing road layout). These straights of course present the teams with a trade off, requiring good downforce elsewhere, whilst as little drag as possible to attain top speed. In that respect Spa represents a similar challenge and so it is no surprise that the team decided to utilise that setup. One thing that does differ though is that in Spa the team removed the Gurney trim from the top flap in order to further reduce drag, whilst in Sochi this remains in place. It's interesting that the team had the forethought to plan for this and means that, that specification of wing was likely available in Suzuka too, owing to the strict customs in place at Sochi making it difficult to bring updates or fly parts in overnight.
McLaren's notable performance gain in Russia was in significant part down to the better use of the tyres - they normally have problems in warming the tyres up quickly enough, which is good for tyre degradation but bad for that one flying lap in qualifying. They also used a different rear wing compared to the previous two rounds in Singapore and Japan, without the serrated trailing edge to the main plane and the leading edge of the flap. In Sochi practice they tested an experimental front wing package, shown here, for their 2015 car, with a small raised section inboard (red arrow). This was removed for qualifying and the race when the team reverted to the normal front wing.
Updates are particularly thin on the ground in Sochi this weekend, owing to strict customs. Most teams have openly admitted that they needed to have parts with them in Suzuka for them to make it across to Russia, meaning they may aswell have run them in Suzuka too.
A new front wing has materialized at McLaren (lower wing in the image above) though which outwardly appears very similar to their old design, in fact the largest change comes to the mainplanes connection point at Y250 (250mm from the front wings centreline, with the mandated neutral section occupying that area). The 500mm neutral section of wing has been a playground for teams since its introduction as although it’s design is the same for each team, how it interacts with other areas can improve performance. In previous seasons the teams have also used the camera housings to influence the flow over the neutral section but for 2014 this was eradicated by the introduction of their mandated positioning further upstream on the side of the nosecone.

You’ll note that in the case of McLaren’s new wing two metal inserts sit either side of the neutral section and are likely being used as a way of controlling how much flex occurs, as the wing deforms under load. The horseshoe metal inserts are shaped in order to retain how the mainplanes connection with the neutral section creates an elongated vortex.
The team were investigating this in Singapore (above) when they installed a camera on the nose of the MP4-29. The camera looks across at dots installed in the front wing endplate and measures the amount of movement, indicating where the team are/were losing/gaining performance.

Outbound of the Y250 connection we can also see that the mainplane and how it splits to form the two part flap is also more convex, adjusting how that section of the wing performs with less deformation. It seems that the team are trying to retain a more stable Y250 vortex assisting the central rearward flow, rather than taking advantage from pivoting/flexing outer elements.
There were no significant new pieces on the Red Bull in Russia as the parts were delayed at customs. The team again ran the new front wing first seen in Japan with the bulbous central section bonded under the nose to increase front downforce. This wing also has a slotted vertical fin (lower red arrow) on the upper forward flap to help turn the airflow around the front tyre, while a second additional L-shaped fin (upper red arrow) is mounted inside the endplates. Again this helps turn the airflow around the front tyre, as opposed to just letting it spill over the top.
17.10 **TORO ROSSO STR9 - BARGEBOARDS**

17.11 **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images from Sochi courtesy of Sutton Images.
Aerodynamic & Mechanical Updates 2014 – Volume 2

TECHNICAL UPDATES – RUSSIA – ROUND 16/19

The F1-Forecast Technical Files
http://www.f1-forecast.com
18. **ROUND 17/19 – USA**

18.1 **VIDEO – MERCEDES TECH OVERVIEW WITH CRAIG SCARBOROUGH**

[by Craig Scarborough from The Racer’s Edge](http://www.f1-forecast.com)
18.2 **FORCE INDIA RUNS BIGGER DISPLAY**

18.3  **Ferrari F14T - 2015-Focused Rear Wing**


In the United States Ferrari debuted a totally new rear wing assembly which will serve as a starting point for the solution on next year’s car. New are the two, small U-shaped slots on the endplate (immediately either side of Shell logo), designed to energize the airflow on the underside of the wing's main plane where it joins the endplate. A not dissimilar solution was introduced by Red Bull (inset) earlier this year in Malaysia, though theirs did not have the Ferrari's horizontal gills at the rear of the endplate and featured different shapes to the back of the endplate and the wing's profiles.
18.4 **FERRARI F14T – REAR WING ENDPLATE GRADIENT SLOTS**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]


Ferrari have made it public knowledge that over the next few GP's the teams will test components that may or may not feature on their 2015 challenger. Parts that will be tested to assess performance and if they're lucky may even be retained as they try to finish the season with a flourish.

For FP1 one of these components made it's way onto the F14T in the form of new rear wing endplates. The design may look familiar to those of you that follow the technical side of the sport as the gradient slots initially adorned the RB10. In the case of Red Bull three slots took the place of the leading edge louvres, making for a more efficient mainplane and top flap (the slots or louvres are used in order to allow pressure to migrate from the high pressure side into the lower, reducing drag at higher speed). In the case of these experimental iterations from Ferrari though, only 2 gradient slots adorn the endplate, inline with the mainplane. The leading edge louvres take care of the airflow distribution / drag reduction of the top flap, however owing to
their desire to increase the AoA/Downforce being generated by the wing they've also reduced
the height of the rear cutout.
The F14T’s rear wing endplates are becoming insanely complex (two leading edge tyre wake slots, mainplane gradient slots, upper louvres and trailing edge strakes to manage vortices), managing all of these flow structures must be incredibly difficult.

Whether the team continue to run this wing throughout the weekend remains to be seen.
As we can see Red Bull have arrived in Austin with a fresh design to their upper Y100 winglet. This may be a development part for the team as, as we know they don't lack downforce. The team have utilised the lower Y100 winglet all season, retaining some of the centralised flow characteristics we'd associate with the Beam Wing that is no longer viable. The use of their upper Y100 winglet has only really been used when the team are in high downforce (street circuit) configuration, owing to how the flow structures work with a rear wing that uses higher AoA (Angle of Attack).

The new design sports 4 wing profiles, 2 ahead of the rearward ones that are more easily visible in the image. A design that bears a significant resemblance to the Mercedes W05 design of which we have earmarked as leveraging the exhaust plume for the enhancement of downforce. As we know the FIA have been keen for a number of seasons now to reduce the exhausts impact on aerodynamics with the teams exploiting it's potential. Things cannot be un-learned though, and even though the FIA have reduced the tailpipe to one with the new powerunits and
centre-lined it's placement the teams will still strive to use its energy. After all it's free and otherwise expended energy, so why shouldn't the teams try to exploit it?

The other issue, at least for the Renault powered teams thus far has been that being so far down on power compared to their Mercedes rivals has meant concentrating on power extraction, rather than a play for aero offset. Now the balance is starting to swing a little and the teams focus some attention on 2015 it's unsurprising that Red Bull reprise their focus on exhaust blowing. It is of course a difficult area of development owing to several factors, including the amount of MGU-H harvesting being done, which reduces the energy being expended. I have however talked before about the use/role of the wastegate and how that could also be used to manipulate and energise the exhaust plume.

To me it seems the overall idea is not only to increase the amount of downforce being generated at lower speed, with the exhaust plume energising the airflow in a way that upwardly ascends and aids in attachment, but to also passively stall the rear wing at high speed (much like we saw with the Lotus, Mercedes & Red Bull DRD experiments).

The addition of the two forward blades to their upper Y100 winglet to me at least is a signal that Red Bull are at least trying to utilise the exhaust plume, like Mercedes. The addition of the forward blades should change the point at which the exhaust plume influences the rear wing and will of course pull upwardly on the flow structures beneath. A point at which the assistance it provides to attachment and therefore increased downforce will swiftly be overwhelmed by too much exhaust flow into the region which will lead to the 'stall' and reduction in drag, aiding top speed.

The onboard rearward facing thermal camera on Bottas' car here showing just how the exhaust plume is being used.
18.6 **Williams FW36 - Revised Brake Duct Fairing**


Among some small but interesting updates on the Williams in the United States is this cut (red arrow) on the large endplate around the FW36’s complex brake duct. Inset is the previous 'uncut' solution.
18.7 **MCLAREN MP4-29 - REVISED NOSE**


On Friday in the United States McLaren tested the modified nose seen here on the right (standard version on left). The central finger section features an additional lightweight fairing underneath (red arrow), which is bonded to the bodywork and hence does not require any new crash tests. This was clearly not an experiment for 2015, since the McLaren-style 'anteater' noses will be forbidden under revised regulations in this area for next season.
McLaren have introduced a new nose for Austin, not only in an attempt of increasing performance and therefore pulling further ahead of Force India but also with an eye on 2015. With the nose regulations changing once more for next season, the teams are eager to explore these consequences. In the case of McLaren the change isn't huge but we do now find a bulge present on the underside of the nose (pelican).

Since mid 2012 the team underwent a philosophy change in which they've attempted to run their nose toward the maximum height available within the regs, born out the promise of more flow under the central channel providing more rearward downforce. Flow en-mass however is not always the best solution, with a more controlled and conditioned flow able to enhance other flow regimes downstream.

The idea of the 'pelican' therefore is to harness the flow in this region, conditioning it in a way that the flatter surface used before it could not. Although it will have a straightline effect (possible flow detachment issues caused by the finger extension blocking airflow and how it
then moves into the low pressure zone behind and a reduction of the boundary layer, which albeit not huge can still have an onward effect) its most marked area of improvement will come in yaw, helping to increase front downforce, as it captures the flow more centrally creating a lower pressure zone in behind.

(In basic terms: Imagine the nose from above with the airflow streaming under the nose, now turn the nose left, the airflow will pool, or create a positive pressure on the surface receiving the airflow. This in turn creates a low pressure zone in behind, which airflow will be eager to fill, speeding up the flow).

Its locale will also likely make small use of the neutral Y250 region, changing how its flow reacts downstream.
Lotus have unveiled their new 2015 nose concept, set to be tested in FP1 by one of their drivers. The team was undecided on Thursday who would debut it.

The design is the result of development for the team's 2015 car, named E23 Hybrid, and reflects the changed regulations that will effectively outlaw the team's current twin tusk nose cone. Lotus have said they don't expect their interim nose to work effectively just yet, given that it has not been designed to work with the E22, but rather aims to allow the team to run some comparisons and get real on-track data.

Technically, the nose itself looks a lot like the current nose, with the gap between the tusks filled. The team has likely gone for the simple route, using the research from the tusked nose to
create the new crash structure. It's possible that for this reason, the interim nose houses a left and a right crash structure inside the shrouding, albeit that the total length of the nose has now shortened (the tusks extended ahead of the front wing). The new nose body stops halfway over the front wing, with two protruding supports serving as the connection points with the front wing.

Interestingly, the tip of the nose is curved up, attempting to get just that little bit of extra air underneath the nose. This immediately indicates one of the biggest challenges for most teams going into 2015, as all current noses that are set to be outruled were designed to maximise airflow underneath the nose, allowing for more downforce generated by the car's floor and its rear diffuser.

Lotus have yet to confirm if they plan to run the nose at the two other remaining events of the season.
On Friday in the United States Lotus used Romain Grosjean's car to trial a new nose which respects the revised 2015 rules in this area of the car, intended to avoid the somewhat unattractive solutions seen this year and ensure the initial emphasis of designs is safety rather than performance. In looks it is not dissimilar to Ferrari's current flat and low shape. Lotus ran it only in the morning session in order to gather data before returning to their familiar 'tuning fork' or 'twin tusk' design in the afternoon.
18.11 **LOTUS E22 – TEST NOSE**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

We knew in advance of the Austin GP that Lotus would trial an interim nose, a first look if you will at the way in which they'll need to approach their 2015 design. Their twin tusk design has been outlawed by the FIA for 2015 as the governing body look to tidy up areas of the regulations that left us exposed to the unsightly appendages cascading off the front of many cars nosecones. The Lotus twin tusk iteration for me was perhaps the cleverest interpretation of the regulations but that doesn't always mean it's the best (remember their FEE exhausts?).

The idea of the new regulations is not only aimed at cleaning up the aesthetics but predominantly enforcing the original intention of lowering the nose tip. This of course means that the teams have to give up some of the centralised flow they are used to and so getting a sighter on this in advance is always welcomed. This initial design is only a step in the direction toward what we will see in 2015 with a much stubbier nose section than the regulations for 2015 call for. It will be interesting to see another array of designs, especially as some more than others will try to use the underside of the nose in tandem with neutral Y250 section of the front wing's mainplane in order to leverage an advantage. The sloping underside of this development
part from Lotus showing us just how much the teams make an effort at getting flow under the nose.
19. **ROUND 18/19 – BRAZIL**

19.1 **RED BULL RB10 - REAR WING UPDATES**


In Brazil Red Bull used the rear wing introduced at the last round in the United States, but with some small, important changes. It features a more complex monkey seat (inset is the previous Monaco-spec, high-downforce design), with two different endplate solutions and different incidence angles on the main plane and flap. Pictured here is Vettel's wing, with four horizontal gills at the top of the endplate. Ricciardo's had just three gills layout and lower incidence angles.
19.2 **FERRARI F14T - ASYMMETRIC REAR SUSPENSION**


On Friday in both the United States and Brazil, Kimi Raikkonen's car had asymmetric rear suspension arms (the suspension geometry was not different, only its assembly). In the inset you can see the top wishbone with a quick prototype cover (red arrows) which contains measuring sensors inside to collect data for the team's 2015 car.
There was a lot of speculation in the United States and Brazil concerning the latest rear suspension and brake set-up on the Ferrari and its potential relevance to next year’s car. The Italian team - unlike rivals Red Bull, Mercedes, McLaren, Williams and Sauber - are not using lighter 4-piston brake calipers. Instead they are employing heavier 6-piston calipers, the same as at the front of the car. As can be seen here, these are combined with a carbon drum that encloses the rear brake assembly and stops heat escaping to the outside of the wheel rim. Instead the hot air from the brakes is blown onto the inside of the wheel. This set-up helps keep the brakes at a higher temperature, which makes them more consistent.
19.4 **FERRARI TESTS NEW SUSPENSION**

[by Gary Anderson from http://www.autosport.com/f1 - [illustrations by Craig Scarborough]

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Ferrari has been testing different rear suspension geometries during recent weekends. The new version is running on Kimi Raikkonen’s car and looks like it has a little more camber change available, while Fernando Alonso has been using the old configuration.

With the very high corner forces, which induces a lot of rear-tyre deflection, F1 cars require around three degrees of negative camber in high-speed corners. If there is not enough dynamic camber change on the suspension itself, it means that more static camber will be needed. This means that at low speed, the tyre contact patch is smaller, giving less grip for in-line traction.

Rear-tyre degradation is a result of too much wheelspin exiting slow corners. This overheats the tyre surface leading to less grip and consequently even more wheelspin.
19.5 **MERCEDES W05 - BRAKE OVERVIEW**


One of the biggest technical issues of 2014 season was the new brake by wire system. This operates on the rear brakes only and is there to help with the brake balance whilst the Energy Recovery System (ERS) is recharging the battery pack during braking. Brake by wire also adds braking power, hence most of the top teams, Mercedes included, opted to use smaller diameter rear discs than in 2013 (the maximum diameter allowed in the rules is 278mm, but there is no minimum) and 4- rather than 6-piston calipers. Earlier in the year Mercedes also used a mix of disc materials, with Carbon Industrie at the front and Brembo at the rear. The Brembo material heats up more easily during the transition between brake by wire, when most of the braking is done by recharging the battery, and normal braking, using the brake pedal pressure through the brake pads and discs. Also note in this drawing the very low bodywork introduced by Mercedes at Suzuka.
19.6 **MCLAREN MP4-29 – FRONT WING & TITANIUM SKID TEST**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

McLaren continue to make tiny steps at improving the MP4-29 toward the end of the season and as you can see when comparing the image taken above (by Giorgio Piola), with the one used previously, we can see that some small notches have been removed from both the trailing edge of the Endplate and the most rearward wing element. You'll note that the notches are not new just enlarged and so it seems that the team are keen to make these ad-hoc changes in order to increase how the flow moves around the front tyre. I'd be interested to know if they went to the expense of making a new endplate for this test as in reality a dremmel may well have dealt the same blow. However we can see that the shaping of the rear wing element has been re-designed, with the outer portion now forming a sort of Gurney, further enhancing the way in which the airflow is outwardly turned.
Something we can see from the image below the team have made great efforts to achieve.
The changes are likely in response to the ones previously made by McLaren to the stiffness of their Front Wing in Sochi. The team ran an extravagant set of pitot tube arrays (above) during FP1 not only to assess the enlargement of these notches but to understand how the car will behave next season, as they trialled titanium skids.
Over the years the teams have migrated from titanium to tungsten as a method of protecting the leading edge of the splitter (tea-tray), with the regulations up until the changes in 2015 had called only for a material of a specific weight to complete this task. In 2015 the regulations specify Titanium as the use of Tungsten has been proliferated by the teams as it is less prone to wear, meaning they could run the splitter much closer to the ground without fear of excessively wearing the plank. Running the splitter closer to the ground clearly has other implications (performance benefits) such as the Front Wing also being in closer proximity to the ground, whilst it allows for a more expansive diffuser (Rake). Understanding and measuring these guiding principles early on will shape development for next season.

As we can see the upshot of using titanium skids (for the fans at least) is that we also get the spectacular effect of a bygone F1 era.
19.7 **TECHNICAL IMAGE GALLERY**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk](http://somersf1.blogspot.co.uk)

A selection of the best technical images from Interlagos courtesy of Sutton Images.
The F1-Forecast Technical Files
http://www.f1-forecast.com
20. **ROUND 19/19 – ABU DHABI**

20.1 **VIDEO – ABU DHABI TECH OVERVIEW WITH CRAIG SCARBOROUGH**

[by Craig Scarborough from The Racer’s Edge]
20.2  **VIDEO – RED BULL FRONT WING ILLEGALITIES EXPLAINED BY CRAIG SCARBOROUGH**

[by Craig Scarborough from The Racer’s Edge]
20.3 **MERCEDES W05 – NEW TURNING VANES**


In qualifying and the race in Abu Dhabi, both Mercedes are using the new turning vanes previously tested only on Friday in Brazil. They differ from the previous design (inset) in that they are made up of four elements instead of three. They complete the complex aero package introduced by the team in Japan which has given them a lap time improvement of three- to four-tenths of a second.
20.4 **McLaren MP4-29 – New Front Wing**

[from http://www.formula1.com] - [Illustrations by Giorgio Piola]

McLaren introduced a new aero package on Kevin Magnussen's car in Abu Dhabi, including a front wing by the team's new designer Peter Prodromou, its totally different concept inspired by that of his former employers Red Bull. The new wing (top drawing) differs from the standard McLaren family in all details, from the main plane, through to the other wing sections and the cascade flaps. The small vertical fences under the wing profiles are also different, as is the endplate, which - like on the Red Bull - is less complex with a straighter shape.
By McLaren's high standards the team have struggled over the last couple of seasons, this has also been a transitional year owing to their change to the Honda powerunit for 2015, whilst serious personnel changes have also been made. One of the major coup's for McLaren was extracting Peter Prodromou from Red Bull, as he'll now head the aero department. Small interim changes to the car since his arrival have had all the hallmarks of his handy work, but in Abu Dhabi we see that the '29' has been treated to several Red Bull-esque alterations.
The new Front Wing is a blatant copy of the RB10's, of course there will be different shaping and AoA on the flaps, cascades, strakes etc but the core ideology of the wing is retained, piece for piece.
The most recent of changes seem to be missing but that’s hardly surprising, given that they were done after Peter’s departure and are part of the evolutionary process he wasn’t privy to. It could be argued that given a good result upon transference to the ’29’ any team could copy the wing from the images available, however they do not fully impart the knowledge of how it operates (understanding how the carbon is laid-up to create it’s dynamic is something you cannot fully ascertain from pictures alone).

The wing’s predecessor clearly shows that there is an ethos to which Peter and his new team are trying to achieve, in terms how the wing is constructed. We know that the flexi-wings of the past created a definite performance advantage and teams can’t simply forget this, granted the deflection tests are now much more stringent but this won’t prevent the teams from trying to circumnavigate them.
20.5 **McLaren MP4-29 – Turning Vanes**

[SomersF1 blog by Matt Somerfield: http://somersf1.blogspot.co.uk]

By McLaren's high standards the team have struggled over the last couple of seasons, this has also been a transitional year owing to their change to the Honda powerunit for 2015, whilst serious personnel changes have also been made. One of the major coup's for McLaren was extracting Peter Prodromou from Red Bull, as he'll now head the aero department. Small interim changes to the car since his arrival have had all the hallmarks of his handy work, but in Abu Dhabi we see that the '29' has been treated to several Red Bull-esque alterations.

Images from AMuS

Having already looked at the teams most obvious alteration/test parts this weekend the front wing lets look at the under chassis turning vanes too. As we can see the new vanes are significantly different in shape. Their design doesn't match that of the RB10 like the Front Wing but it is a departure from the fairly basic appendages they replace. The most forward element is the largest, contra to the previous design, whilst the rearward element does bear some resemblance to the Z styling seen on the RBR vanes. The change in turning vanes falls inline with the 'pelican' underbelly added to the nose at the last race, whilst of course making better
use of the new flow regimes generated by the new front wing. (Turning Vanes are used in order to condition and manipulate the airflow moving along the car's centreline, they are of particular importance when the car is in yaw, as they protect the centralised flow from the wake produced by the front wheels).

Above: The older spec turning vanes