drivers, to your cars please

PDVSA
PDVSA
PDVSA
RENAULT
RENAULT

PDVSA
PDVSA
PDVSA
RENAULT
RENAULT

FIAT

Red Bull

Santander
Cinturato
FIAT

McLAREN CARS
10
REYNOLDS
ALUMINUM

GOODYEAR
Valvoline
Santal
parmalat
16

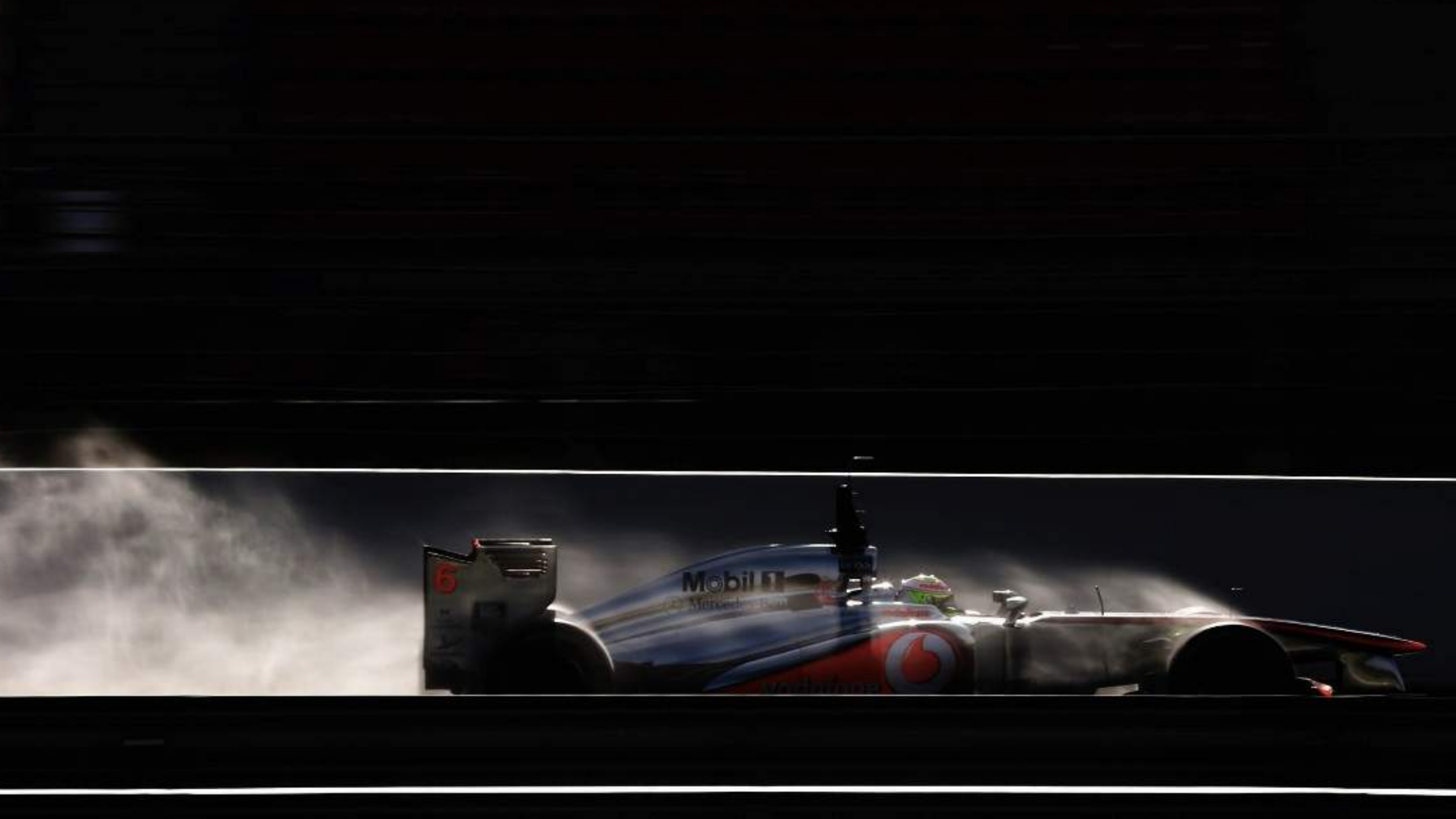
24
HESKETH
James
GOOD

Sir Stirling Moss
7
24
99

Marlboro
Marlboro
HONDA
Marlboro
HONDA
1
Shell

MONSTER ENERGY
EPSON
PETRONAS
PETRONAS SYNTIUM
44
QUALCOMM
PIRELLI
PETRONAS SYNTIUM
#KeepFightingMichael
P ZERO

AIRBUS
RENAULT
AIRBUS
truphone
PIRELLI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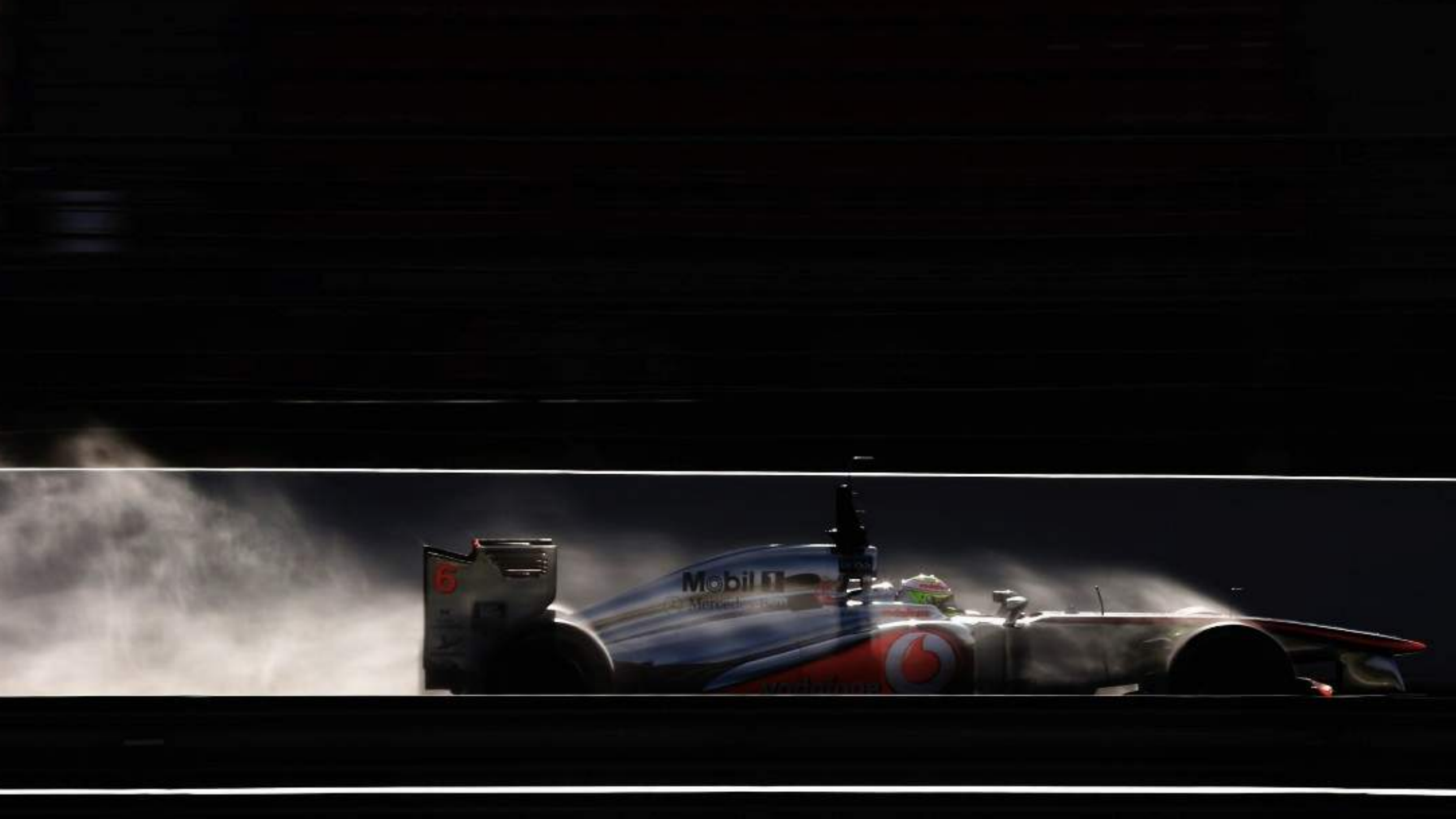
Mobil 1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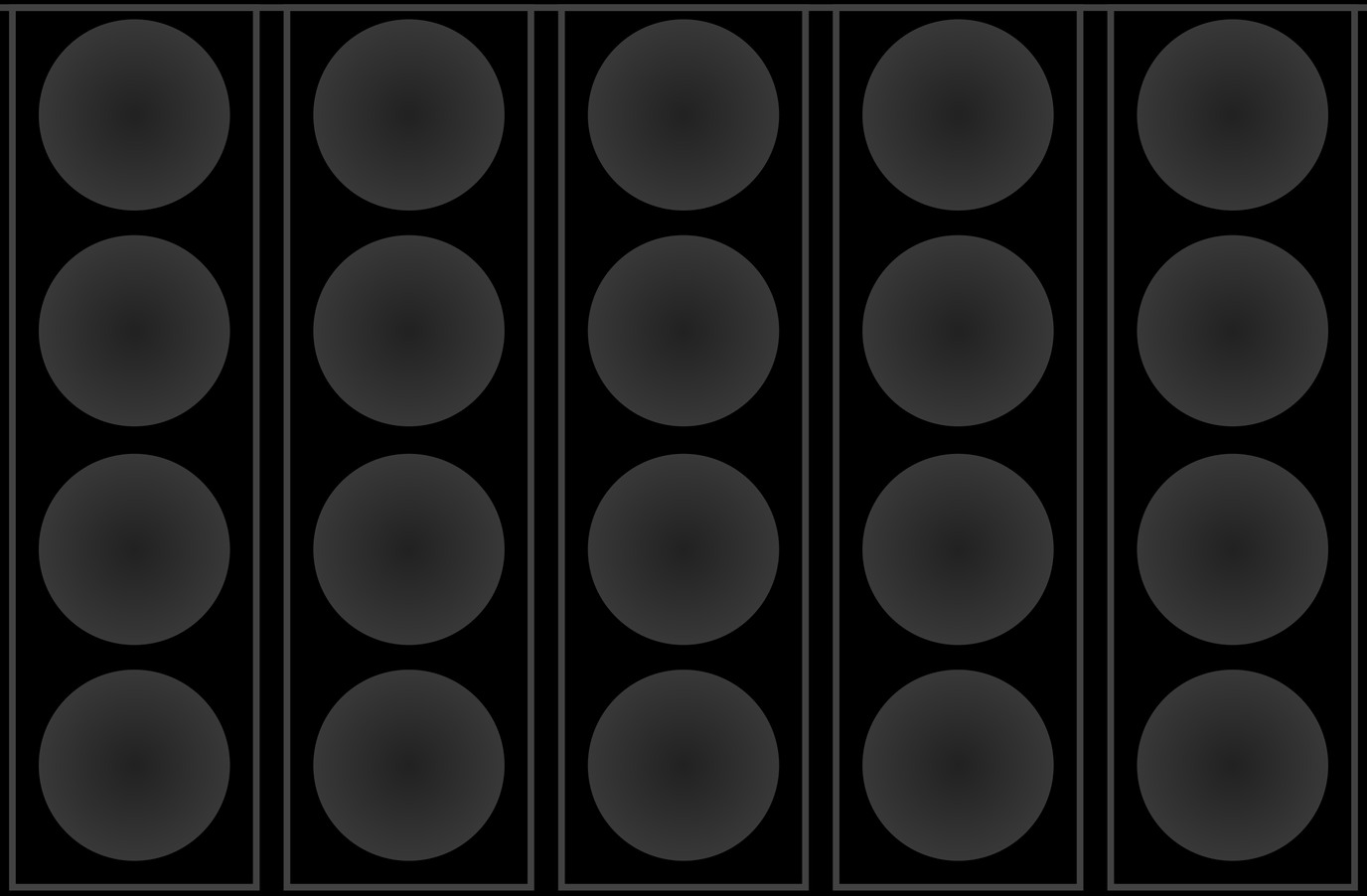
Mobil 1

Formula One and its Contributions to Healthcare



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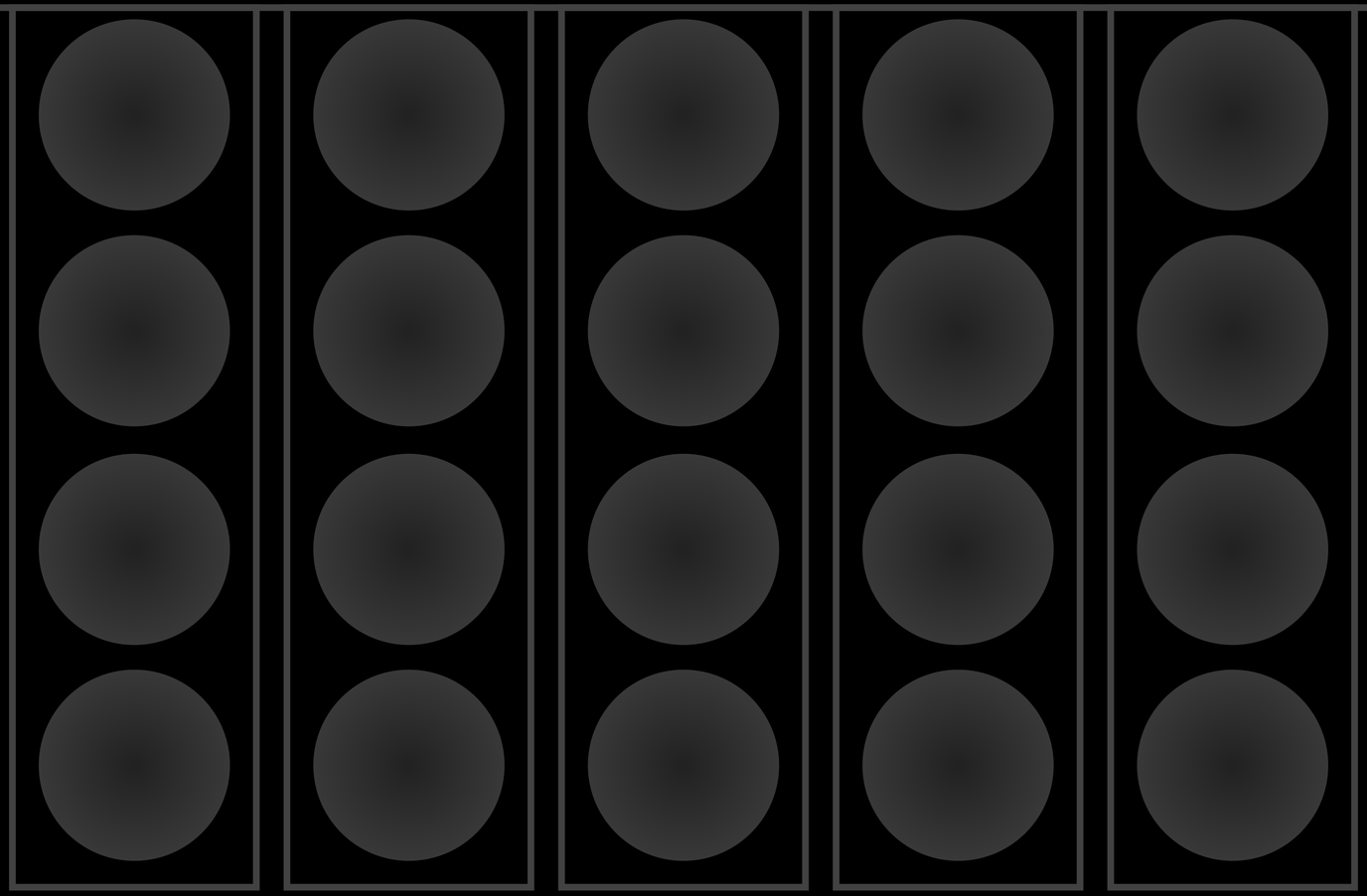

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THE NEED FOR SPEED

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THE NEED FOR SPEED

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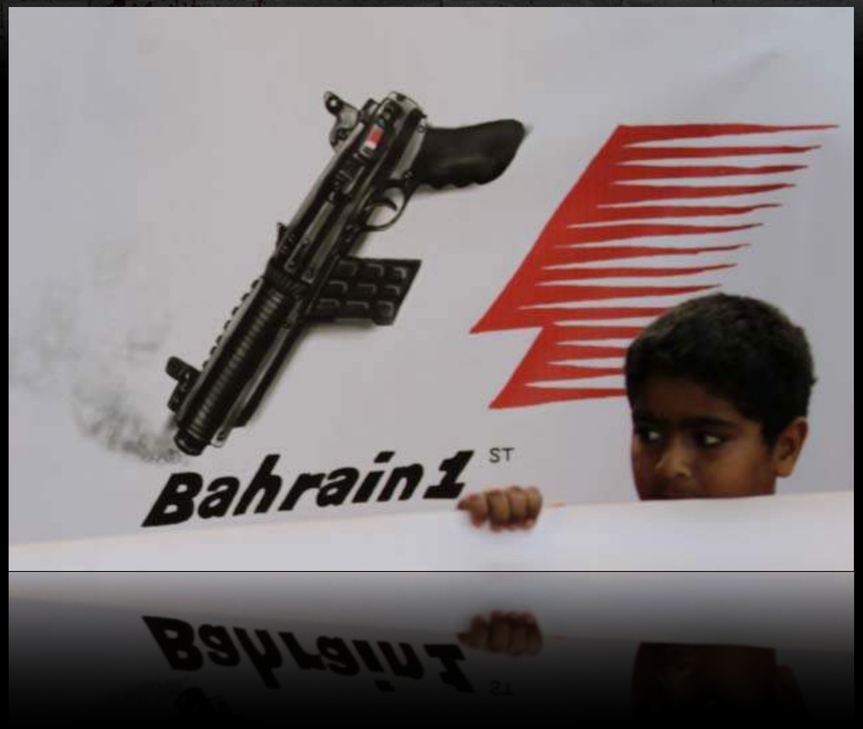

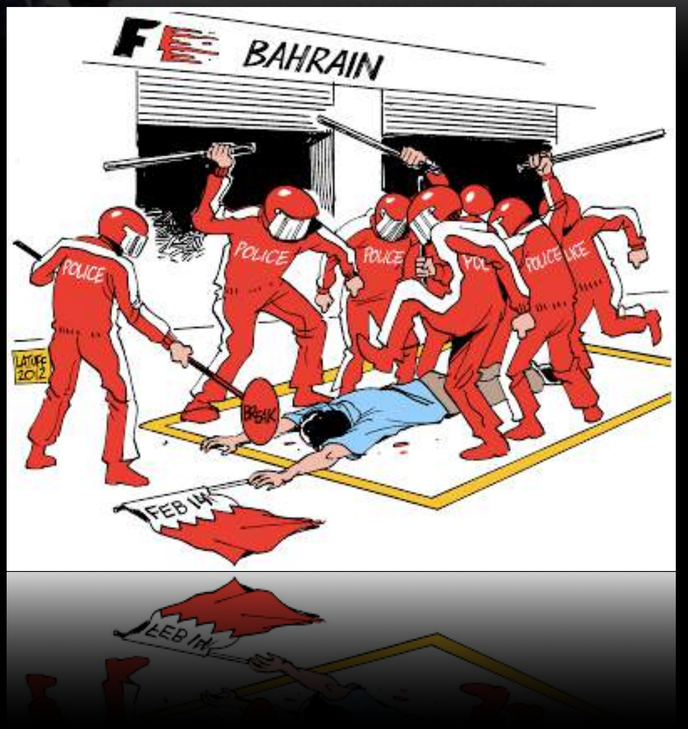

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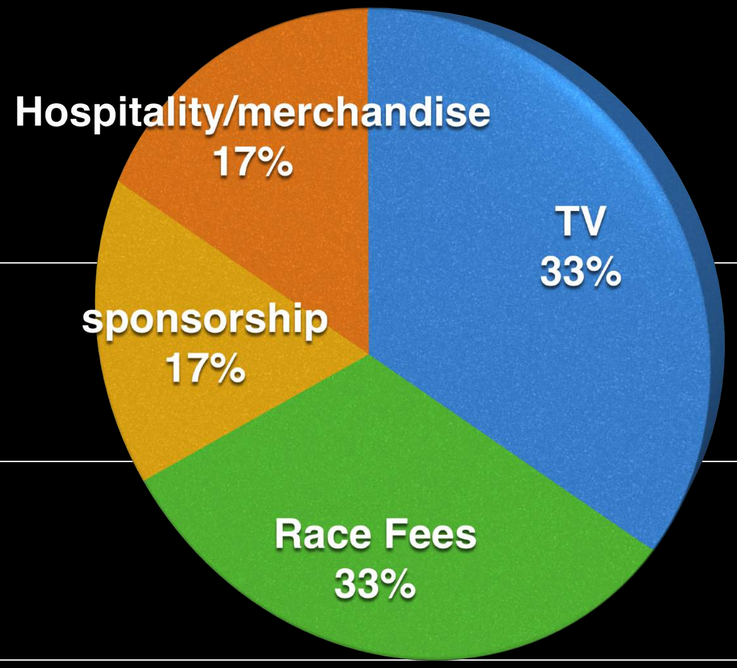
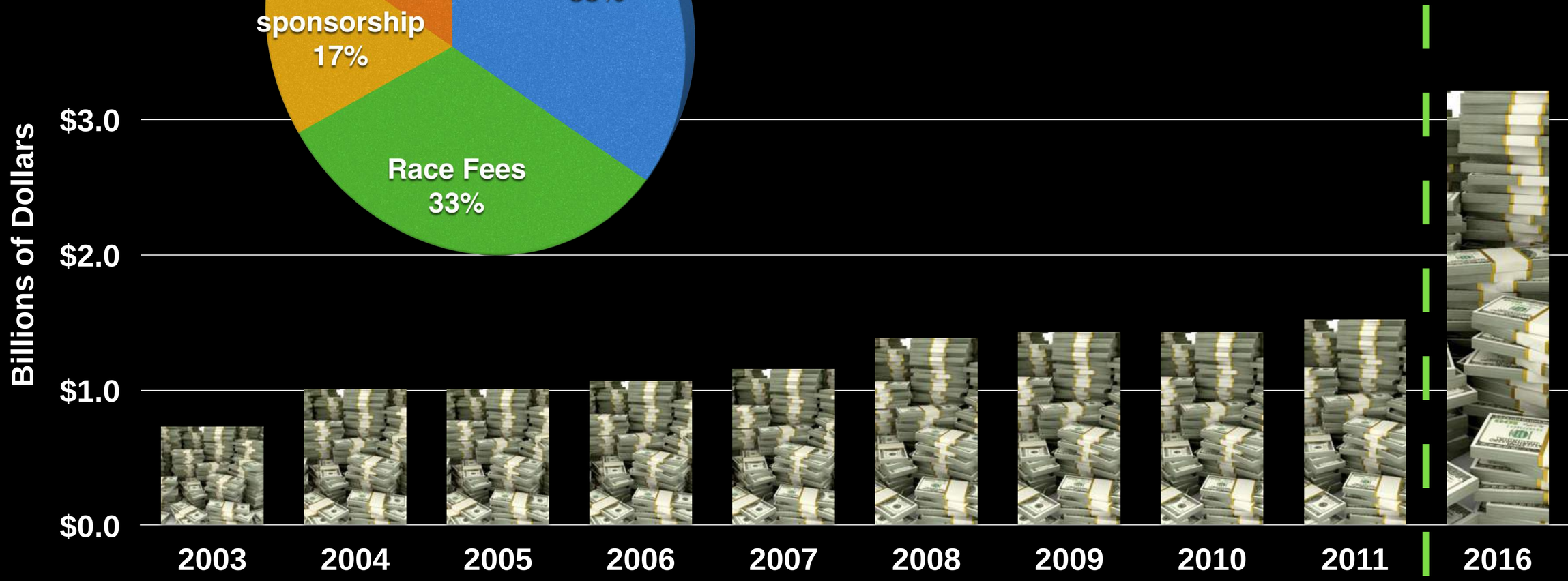
How Revenue is Generated in F1



multi-billion dollar revenues



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Jenson Button

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“To understand the intensity of driving an F1 car, you have to be in it. When you're driving a 750hp machine at 200mph, the noise and the vibrations are incredible.

The G-force when you take big corners is like someone trying to rip your head off.

You hit the brakes, and it feels as if the skin is being pulled off your body.”

Jenson Button

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teamwork

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teamwork safety

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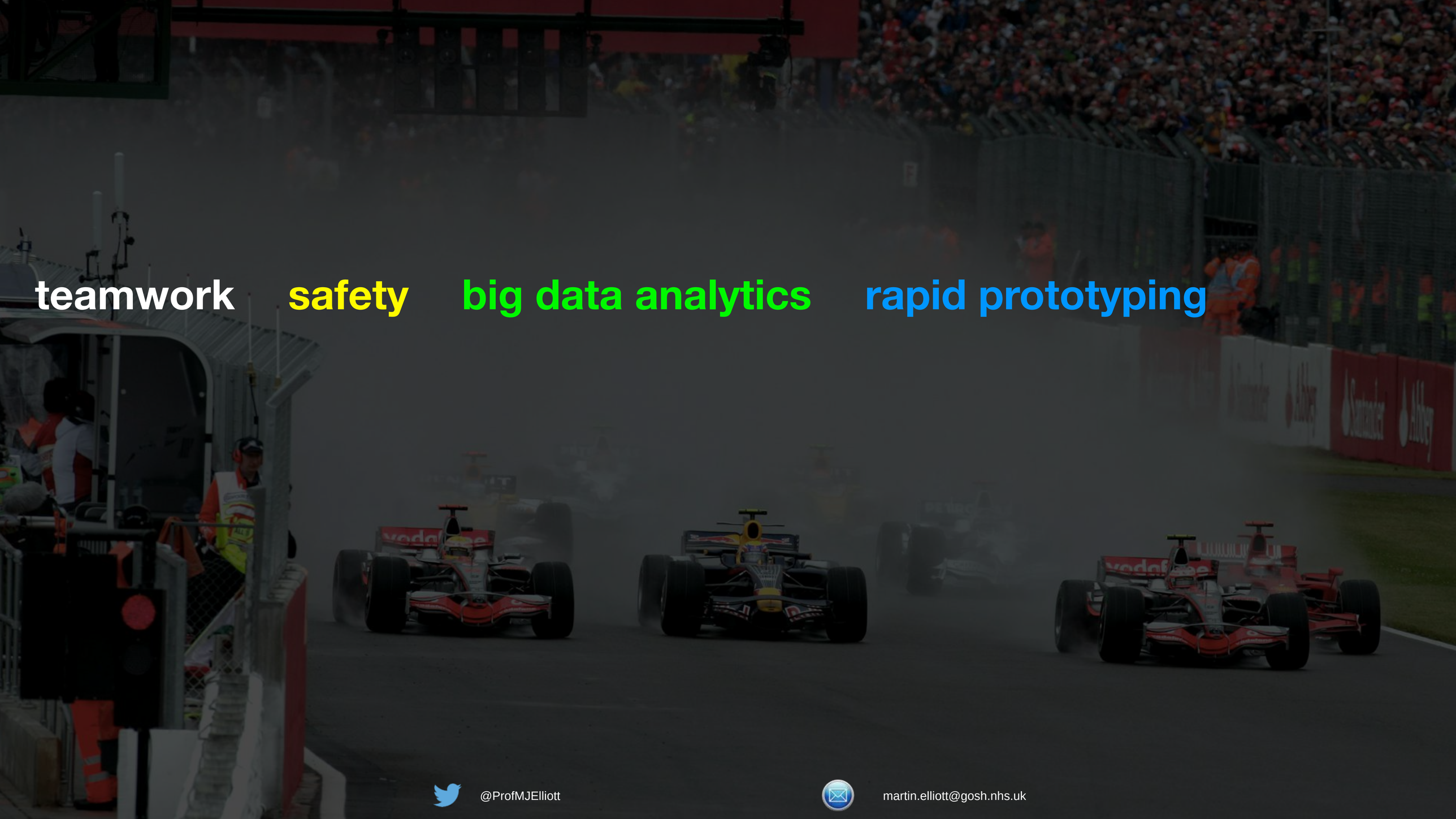

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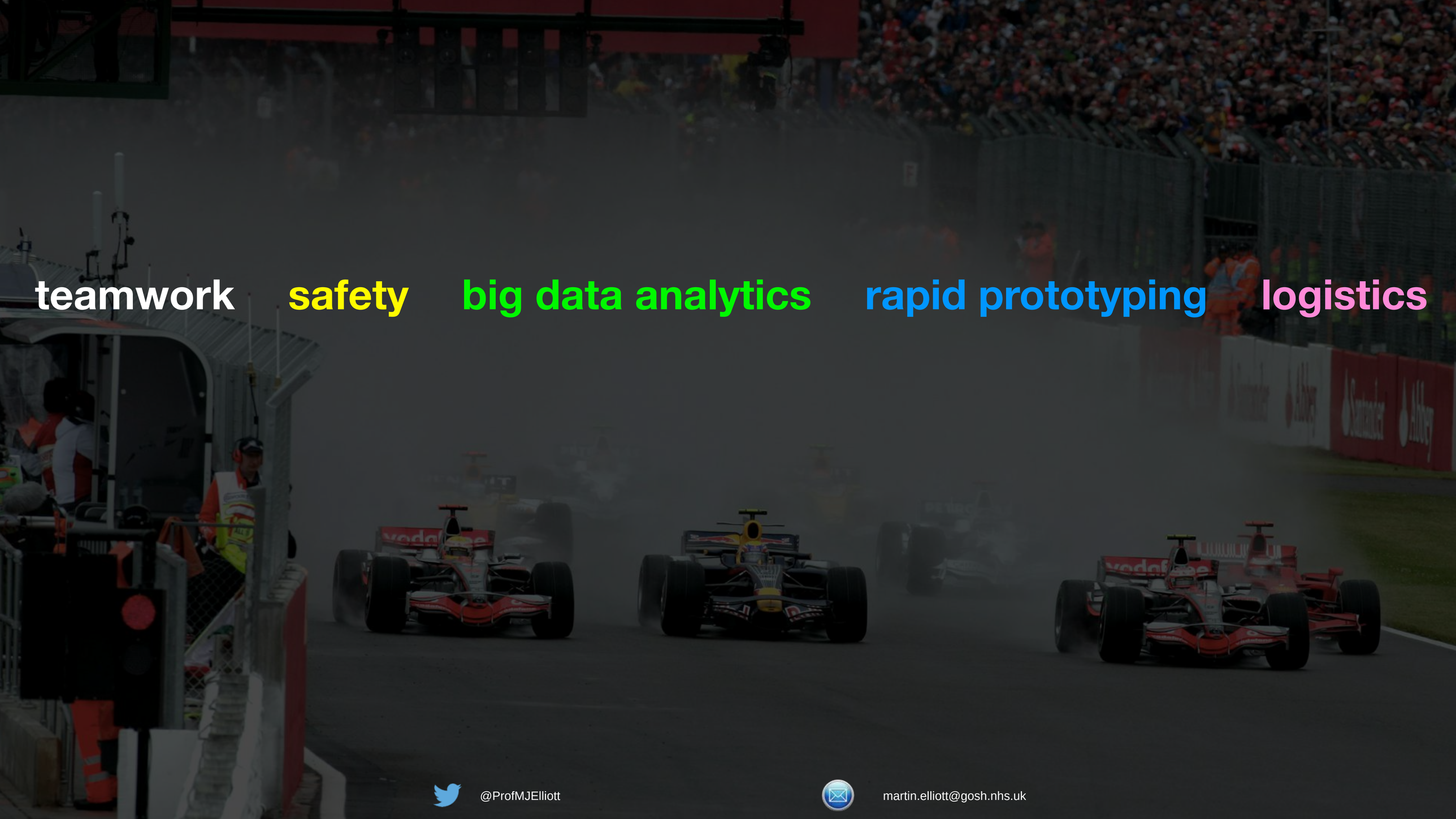

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teamwork

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bristol

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bristol

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"…the transfer from the operating theatre to the intensive care unit is one of the most difficult stages in the care of a child."

p. 214, Learning from Bristol (2001)

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Volume 119 Number 4 Part 1 April 2000

The Journal of
THORACIC
AND
CARDIOVASCULAR
SURGERY

HUMAN FACTORS AND CARDIAC SURGERY: A MULTICENTER STUDY

Marc R. de Leval, MD[a]
Jane Carthey, PhD[a]
David J. Wright, PhD[b]
Vernon T. Farewell, PhD[b]
James T. Reason, PhD[c]
All United Kingdom pediatric cardiac centers

Objective: To study the role of human factors on surgical outcomes, with a series of 243 arterial switch operations performed by 21 surgeons taken as a model.

Methods: The following data were collected: patient-specific and procedural variables, self-assessment questionnaires, and a written report from a human factors researcher who observed the operation. The relationship of patient-specific variables to outcomes (death and death and/or near-miss) was used

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Volume 119 Number 4 Part 1 April 2000

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HUMAN FACTORS AND CARDIAC SURGERY: A MULTICENTER STUDY

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accurate, cross-checked handover is critical

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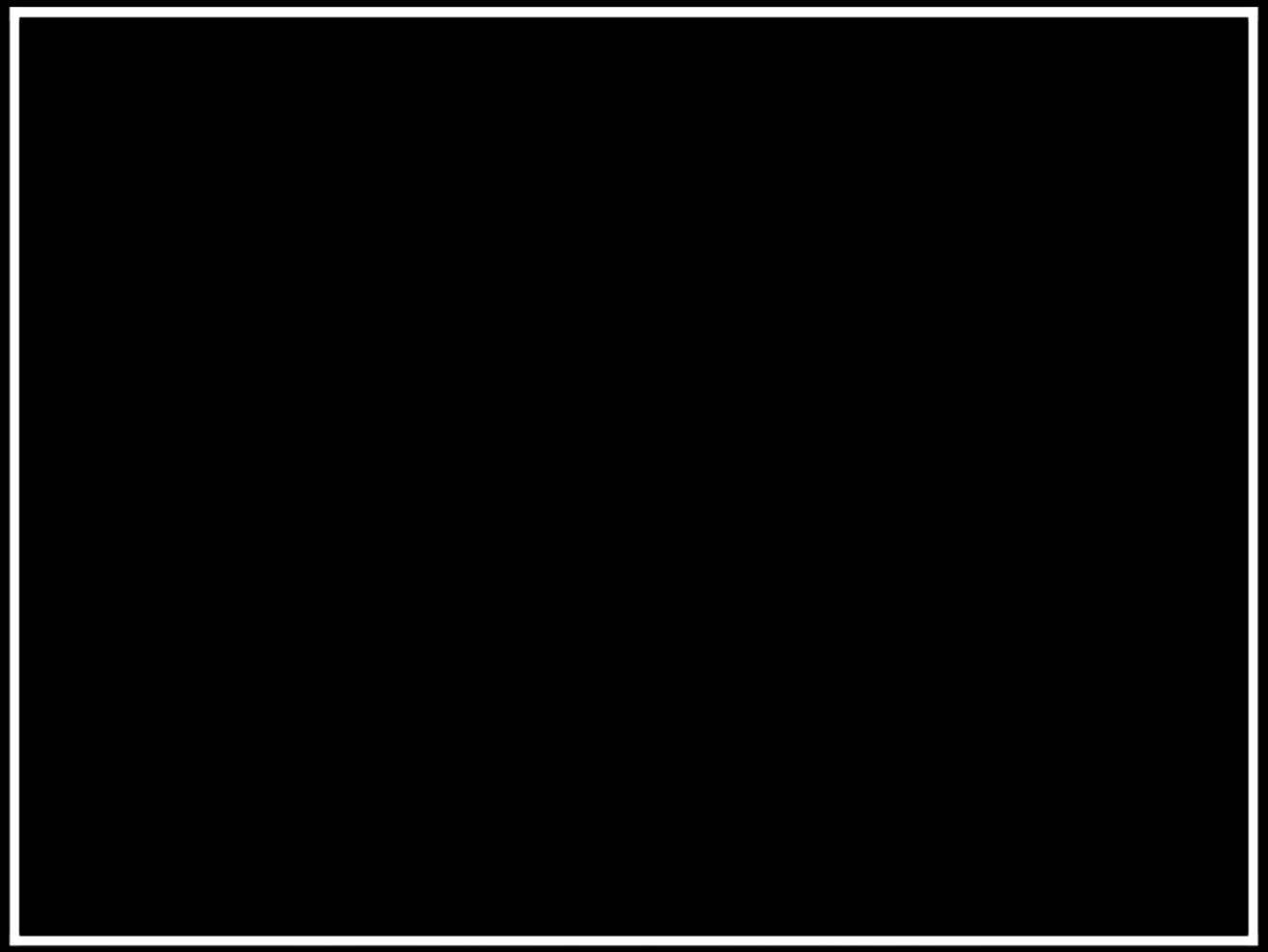

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If they can do it,
why can't we?

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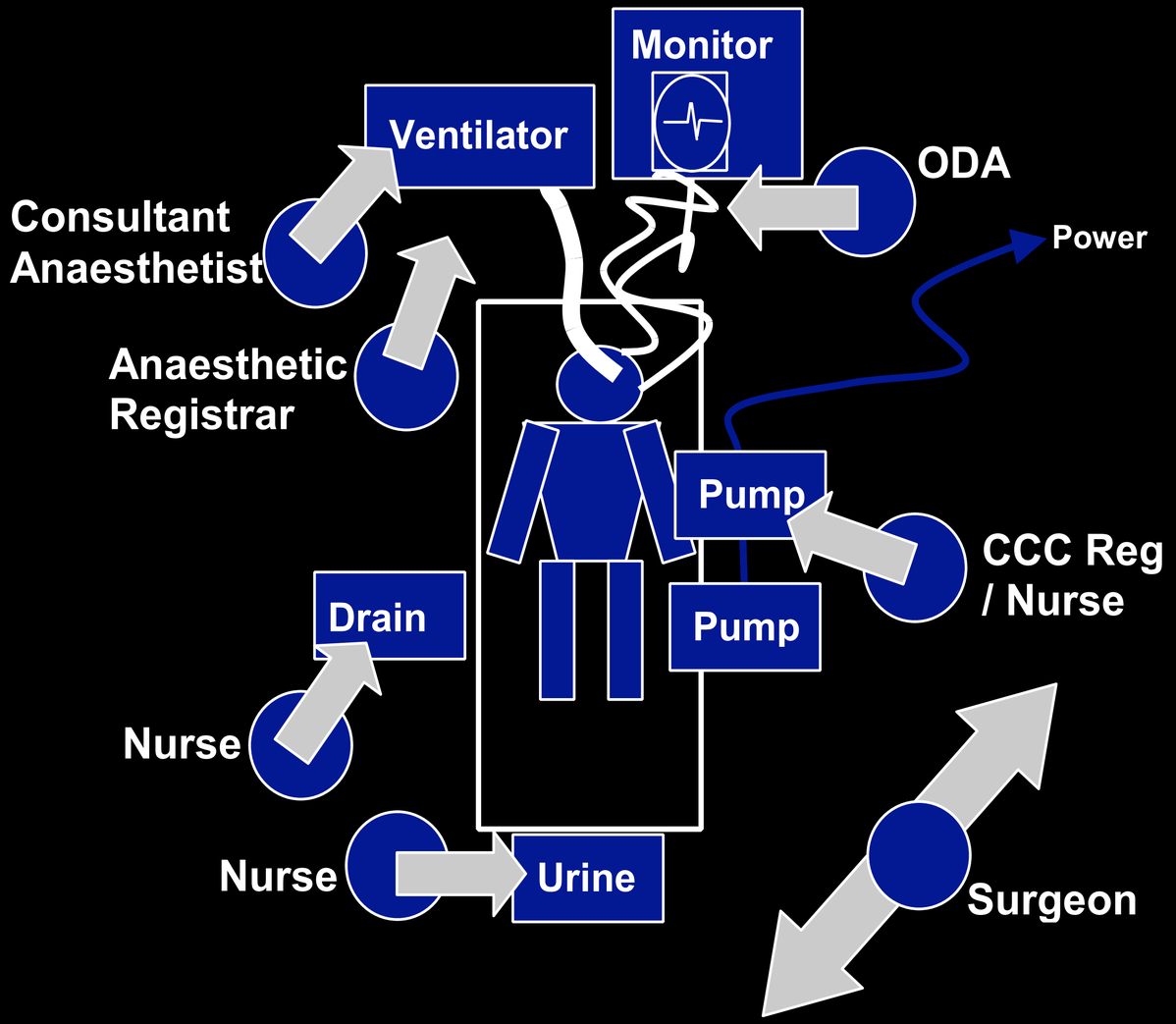

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Maranello

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Nigel Stepney 1958 -2014

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“..I was amazed at how clumsy and informal the hospital handover was.”

Nigel Stepney 1958 -2014

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Nigel Stepney 1958 -2014

“..I was amazed at how clumsy and informal the hospital handover was.”

“..and I couldn’t work out who was in charge.”

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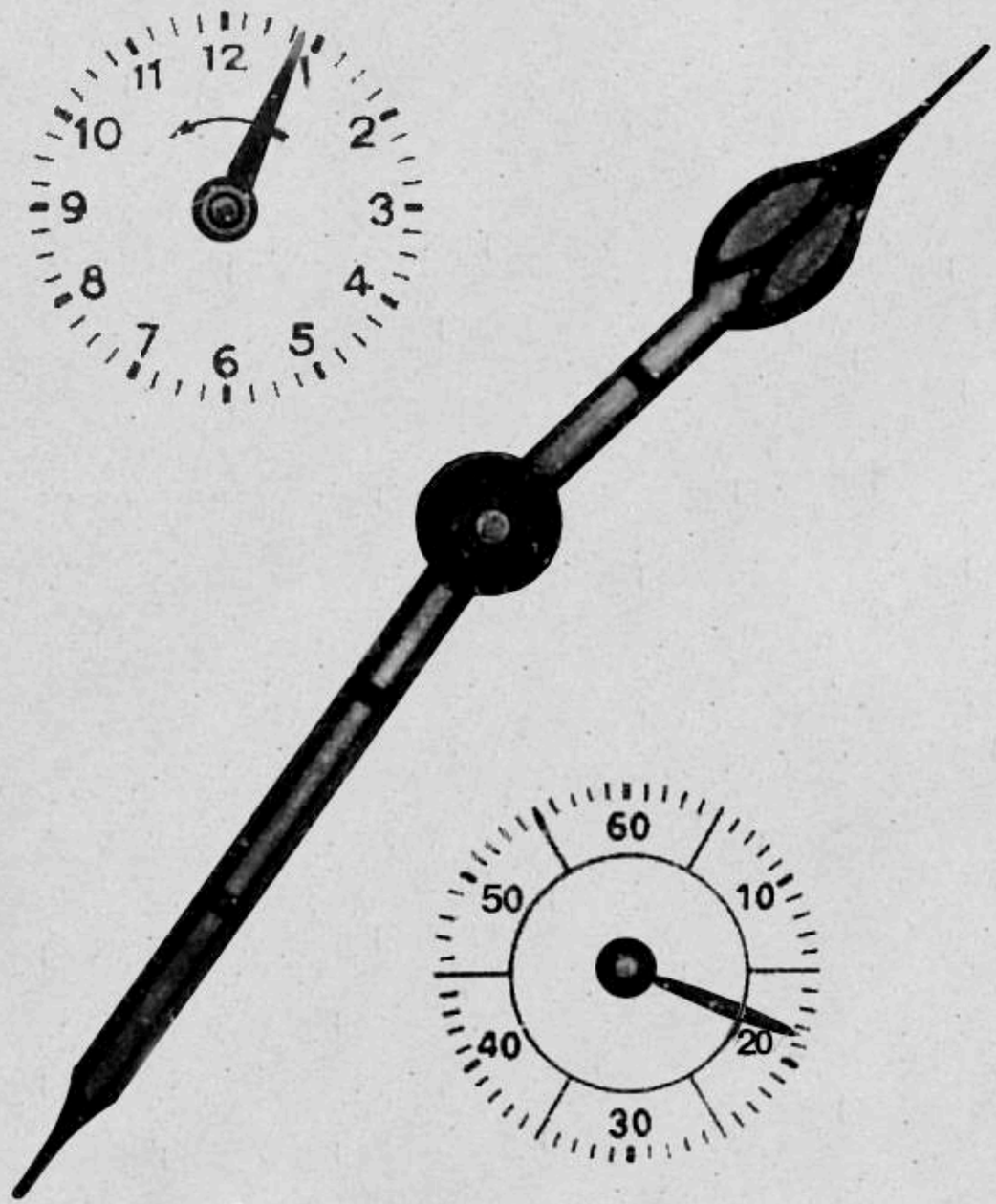

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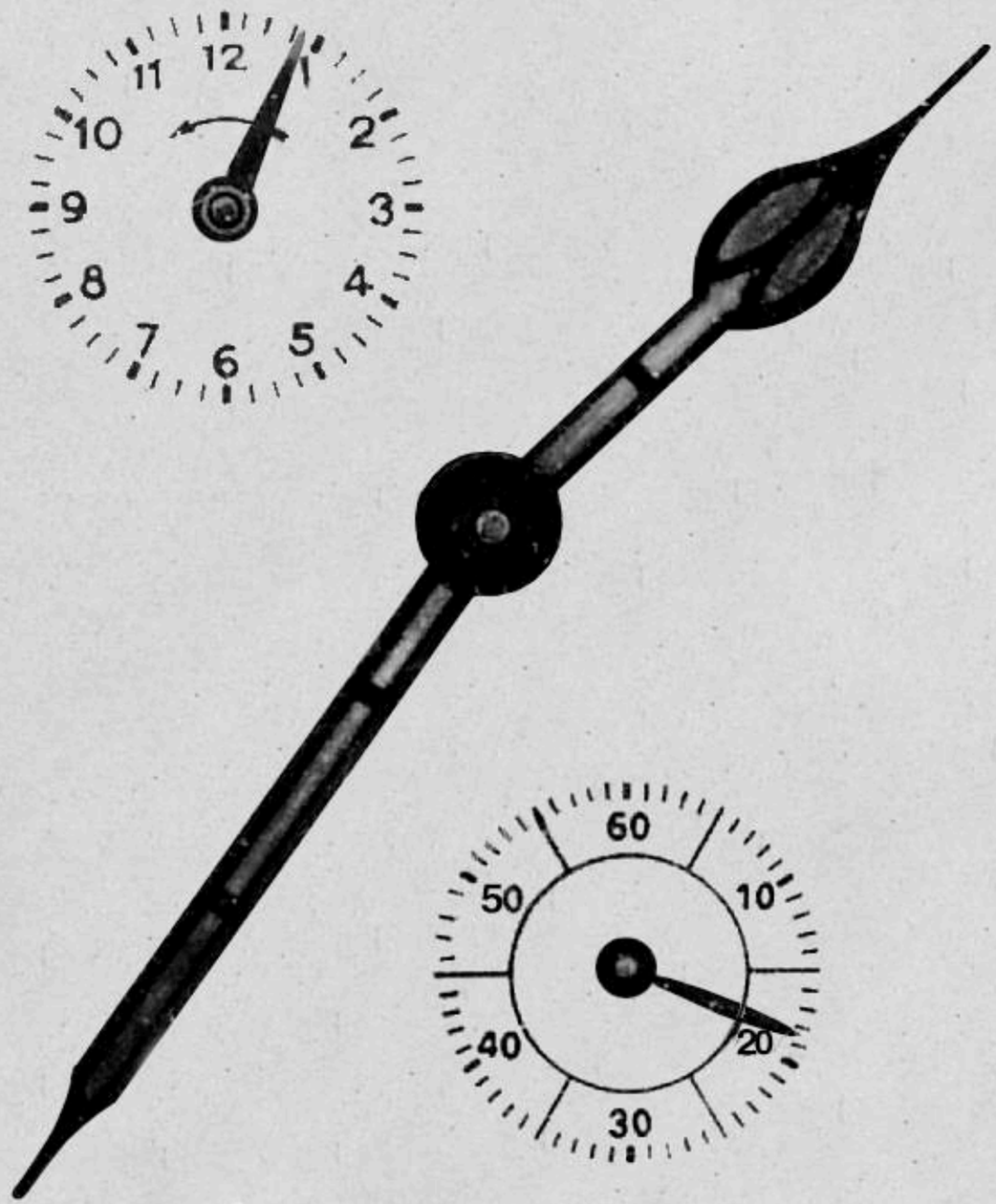

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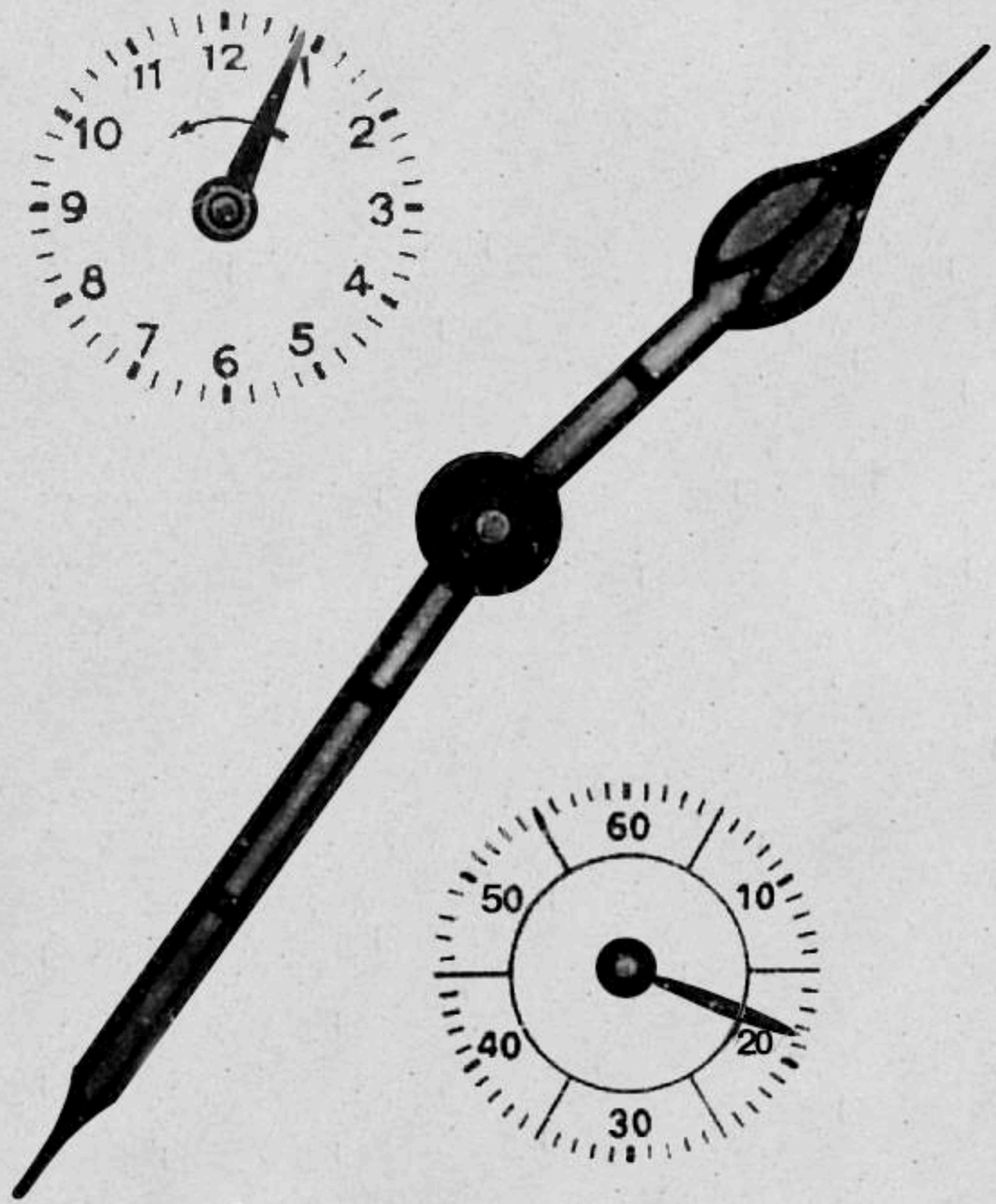

Round Table Talks

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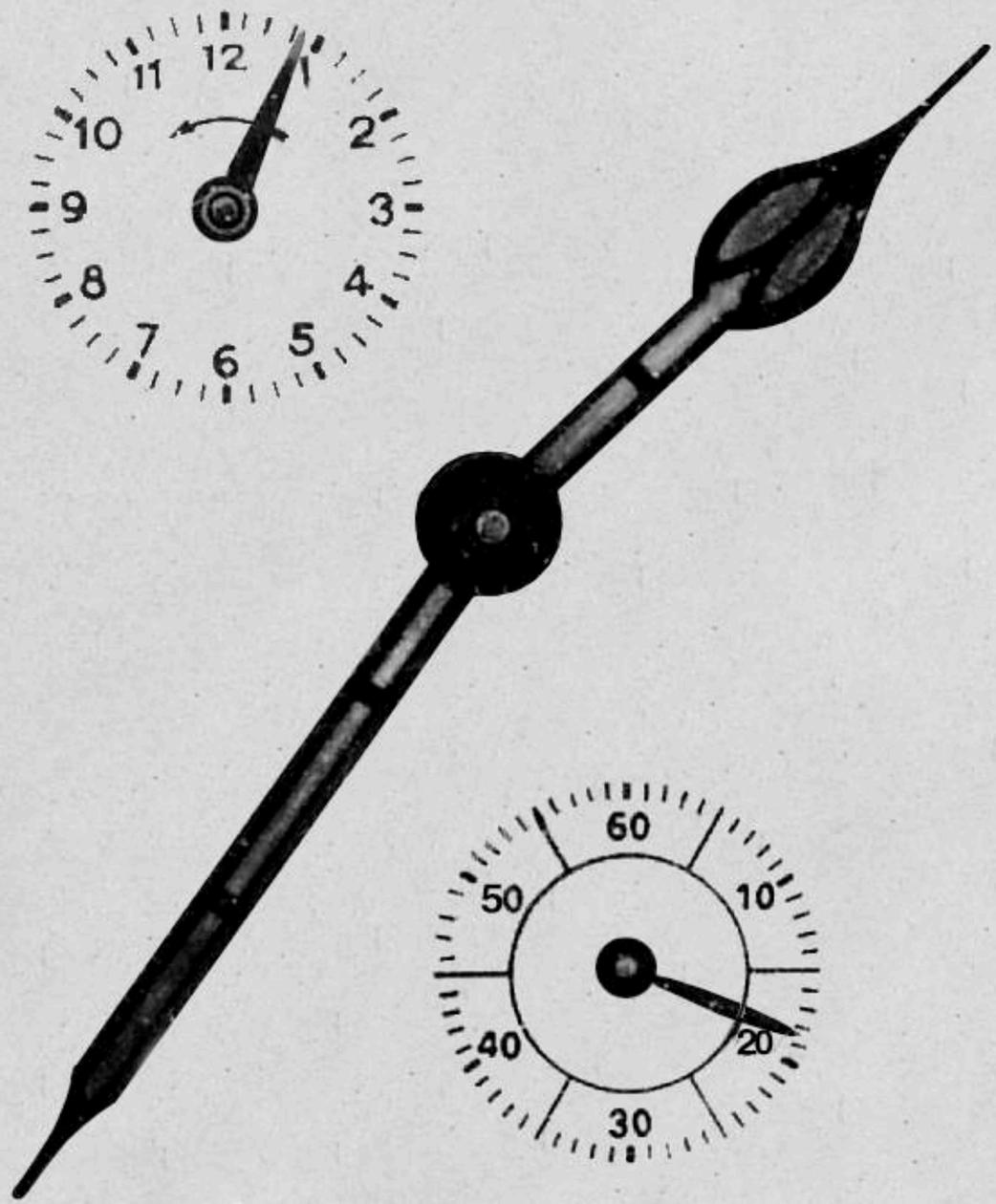

Round Table Talks
map process

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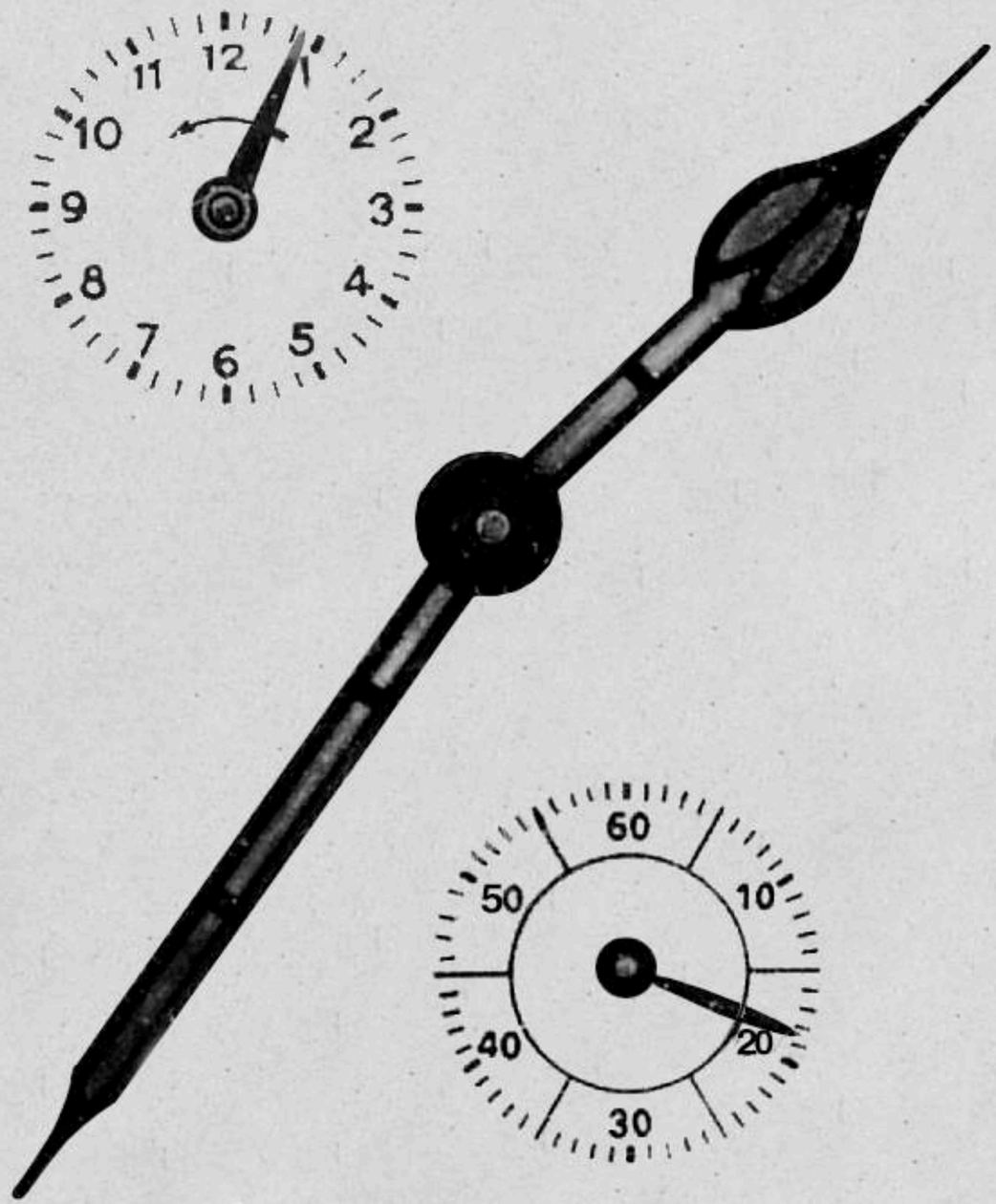

Round Table Talks

map process

imagine

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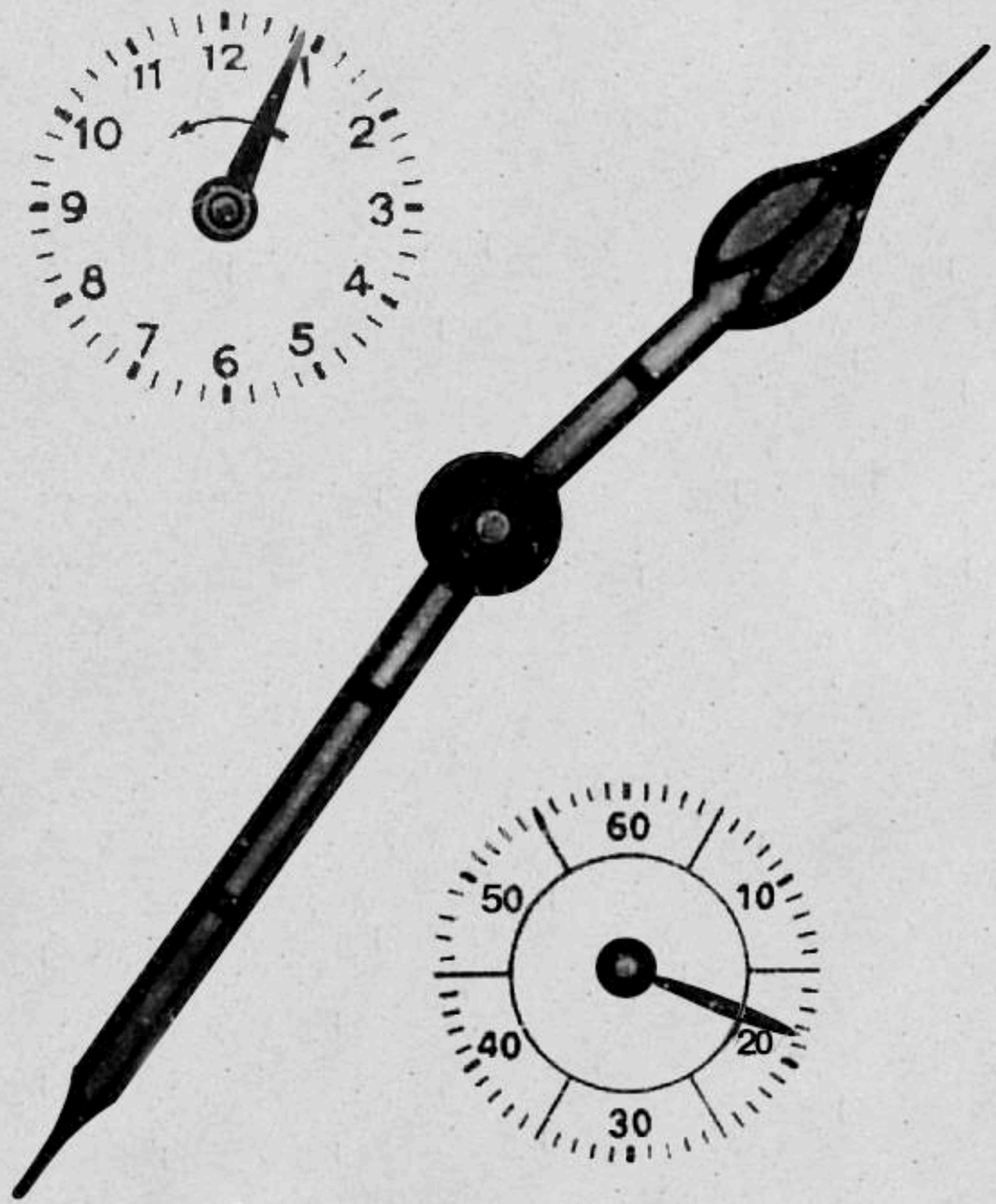

Round Table Talks

map process

imagine

plan

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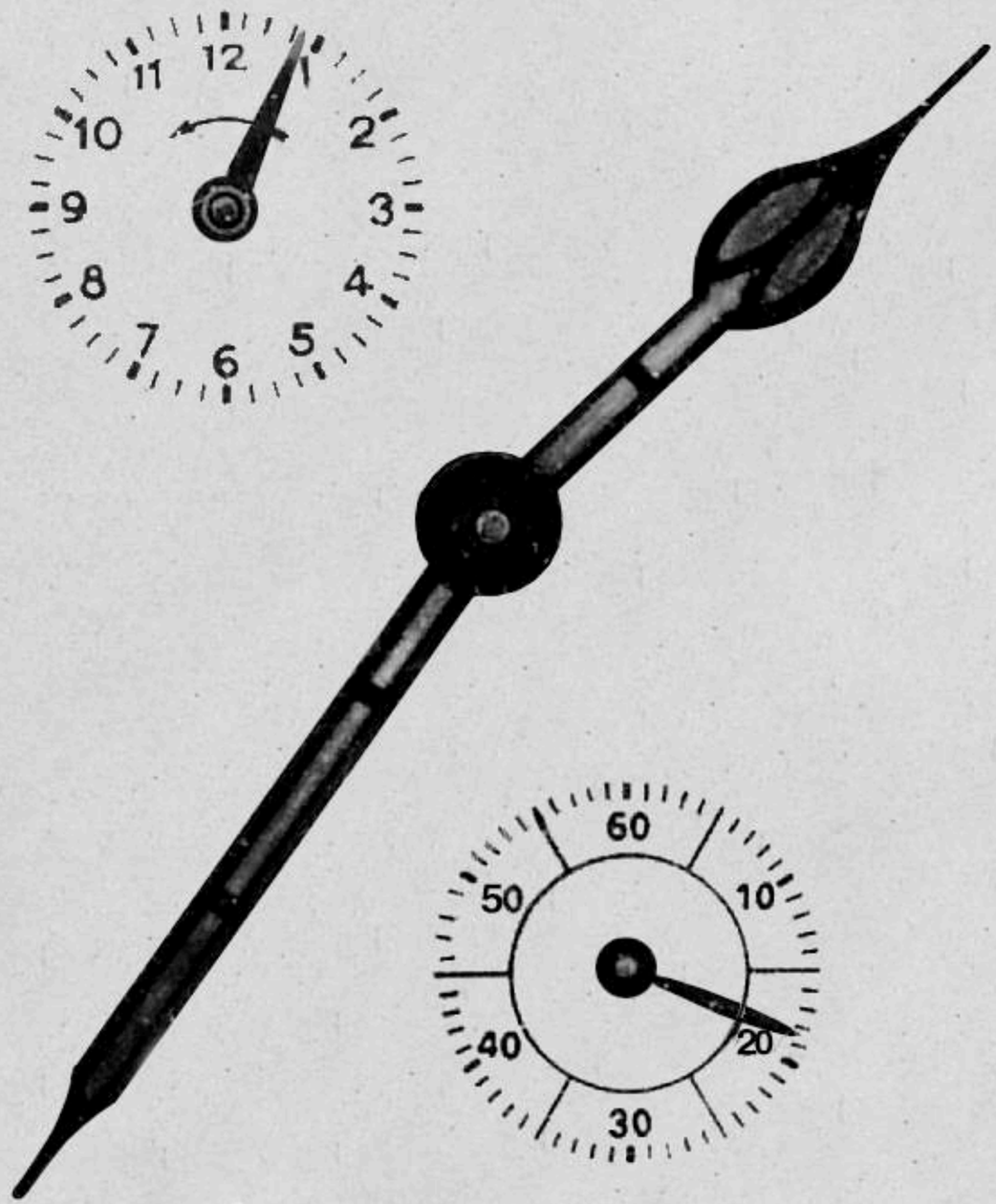

Round Table Talks

map process

imagine

plan

mentally

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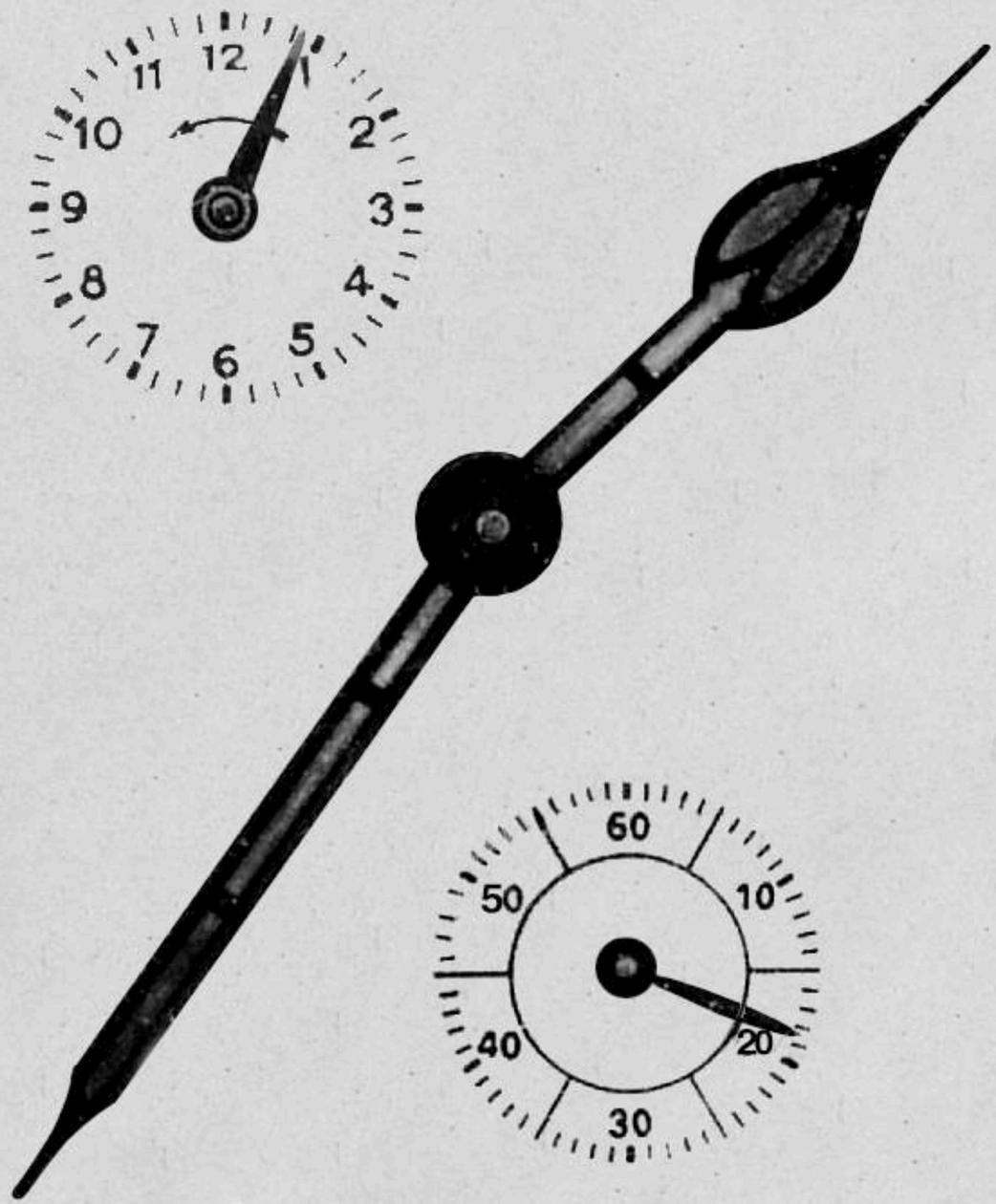

Round Table Talks

map process

imagine

plan

mentally

our process map was **10x**

more complicated than

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leadership

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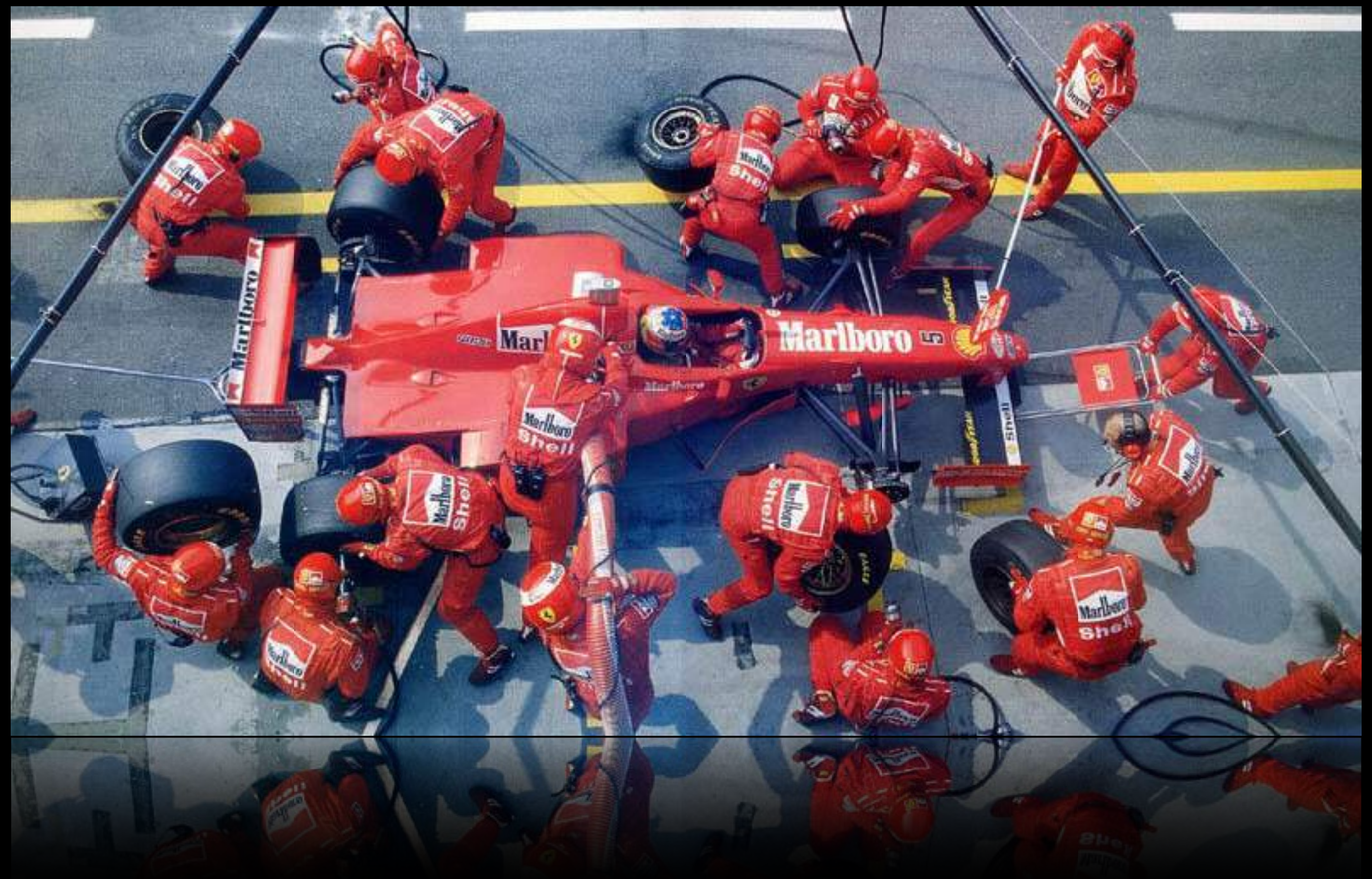
leadership



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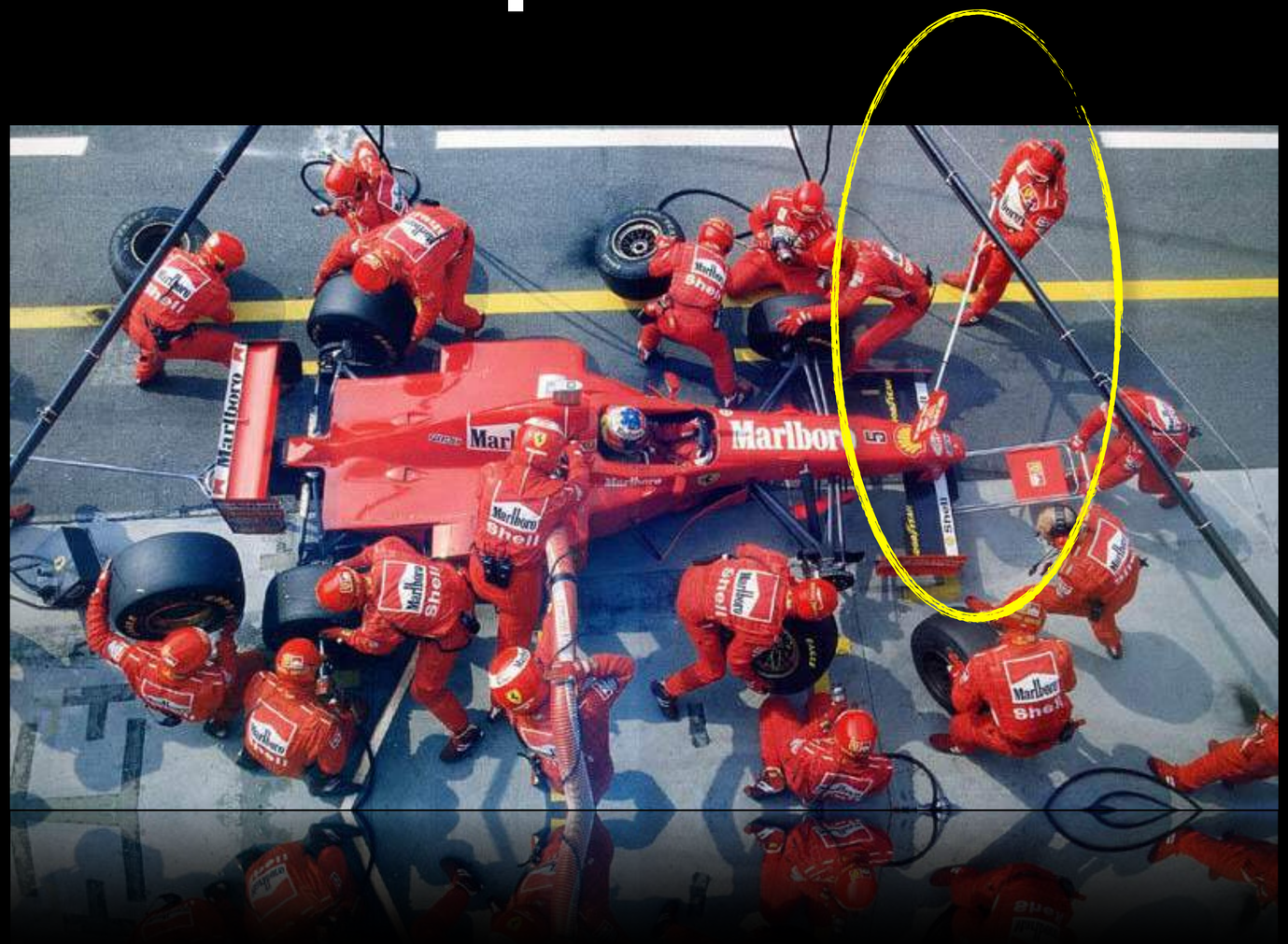
leadership



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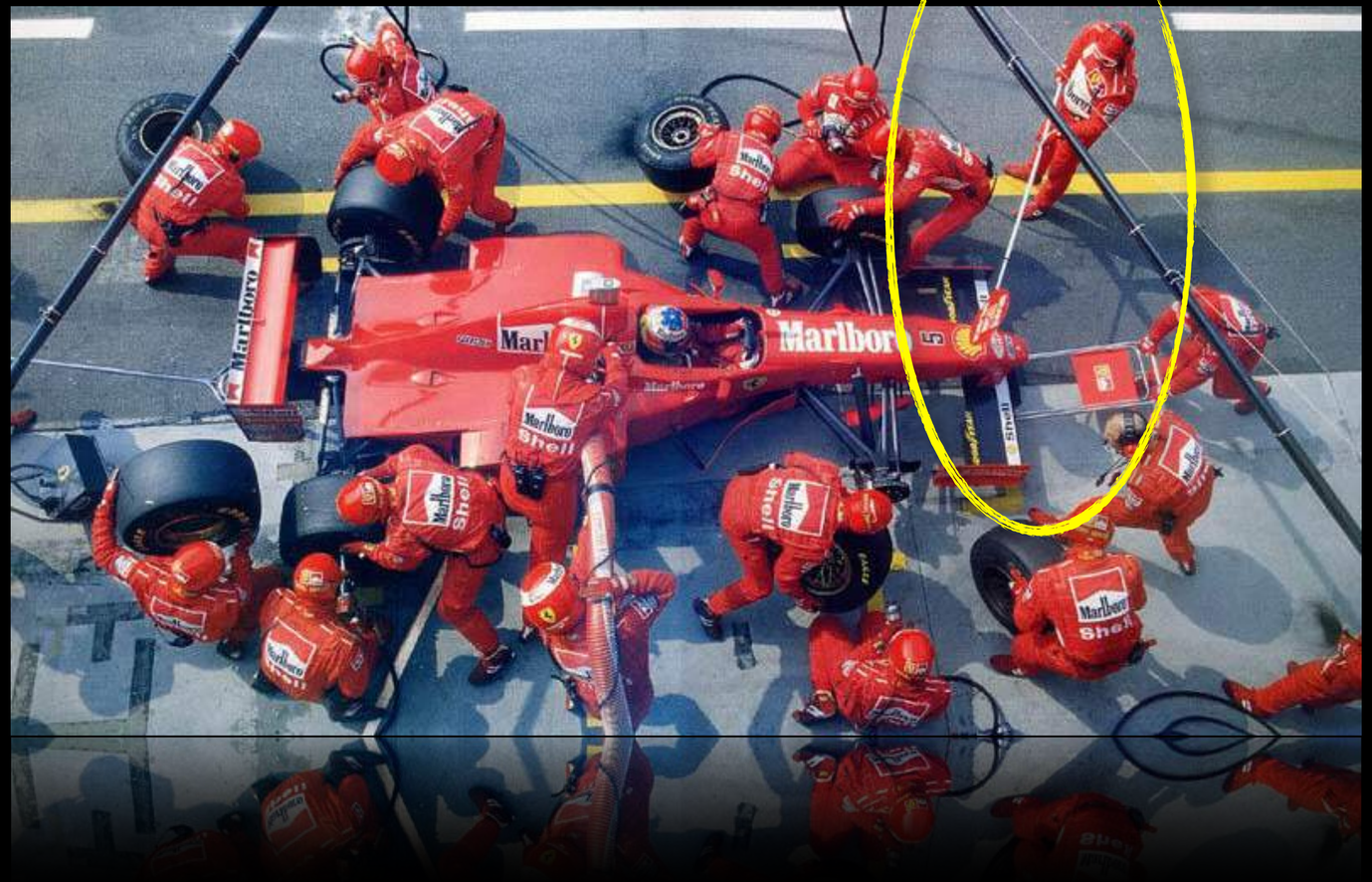

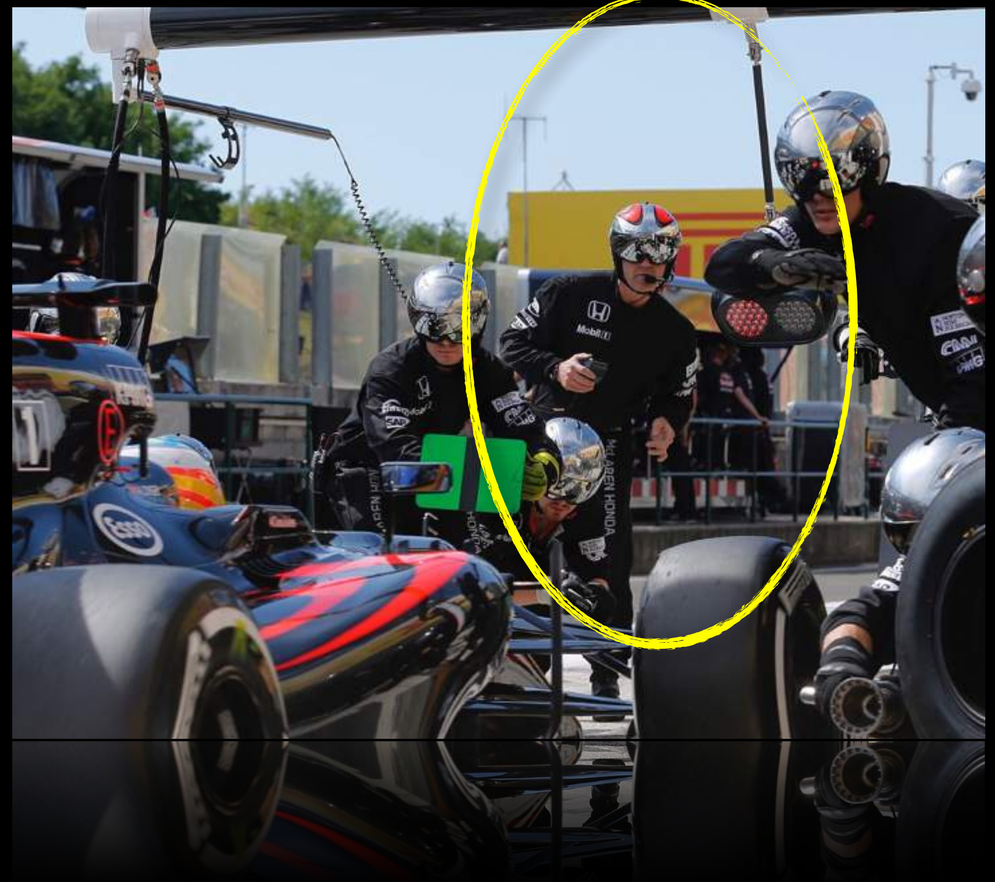

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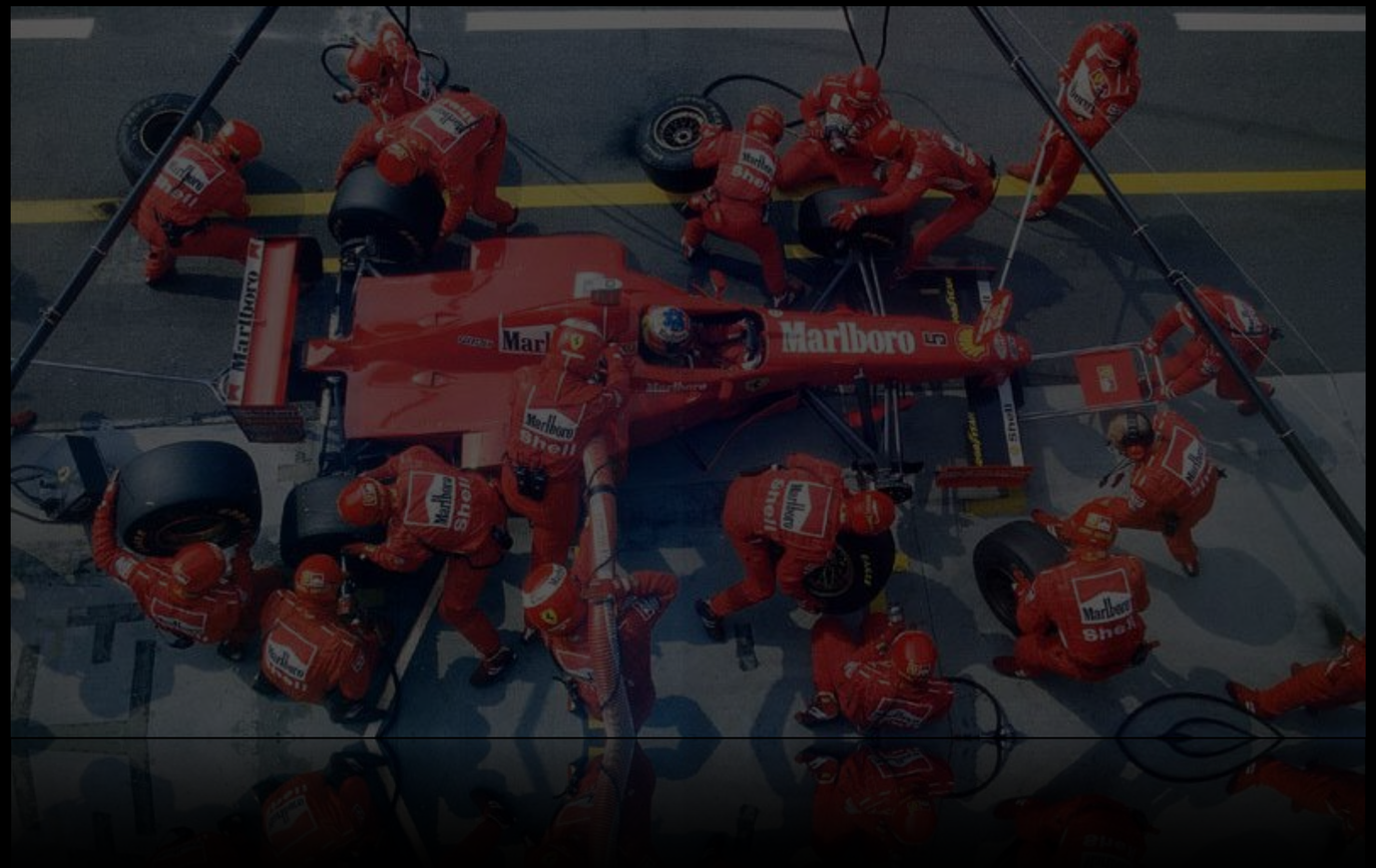
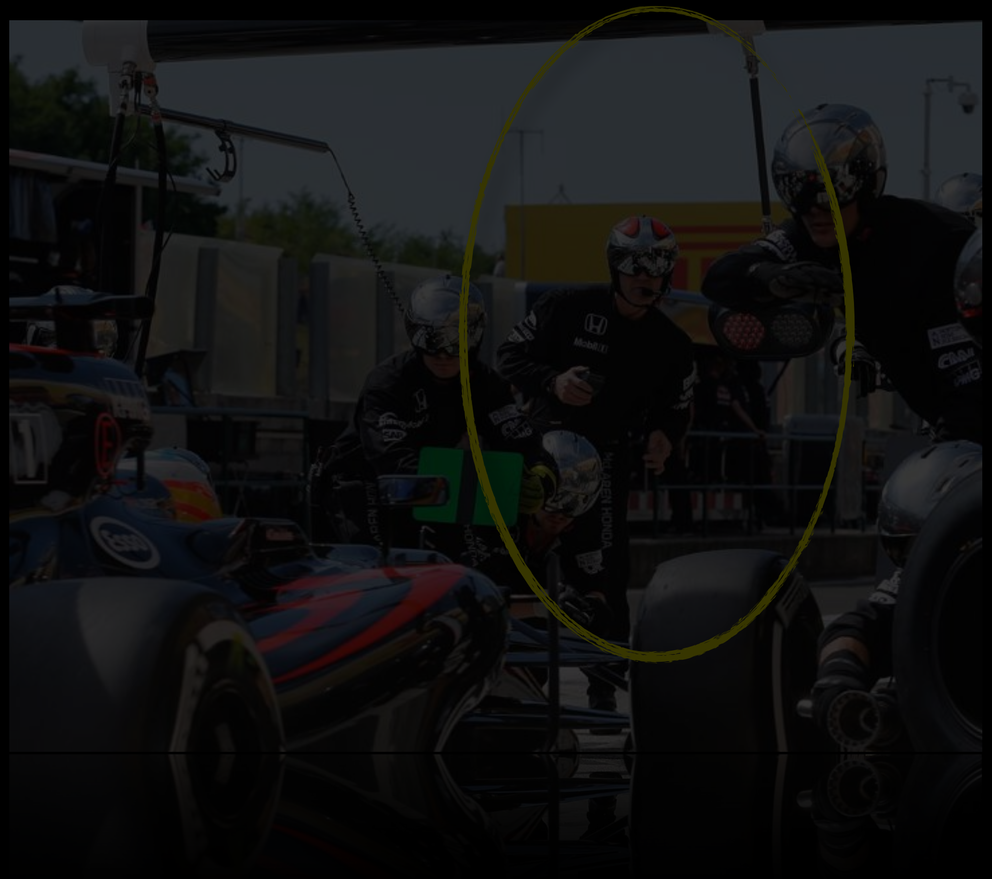
leadership

unclear who was in charge





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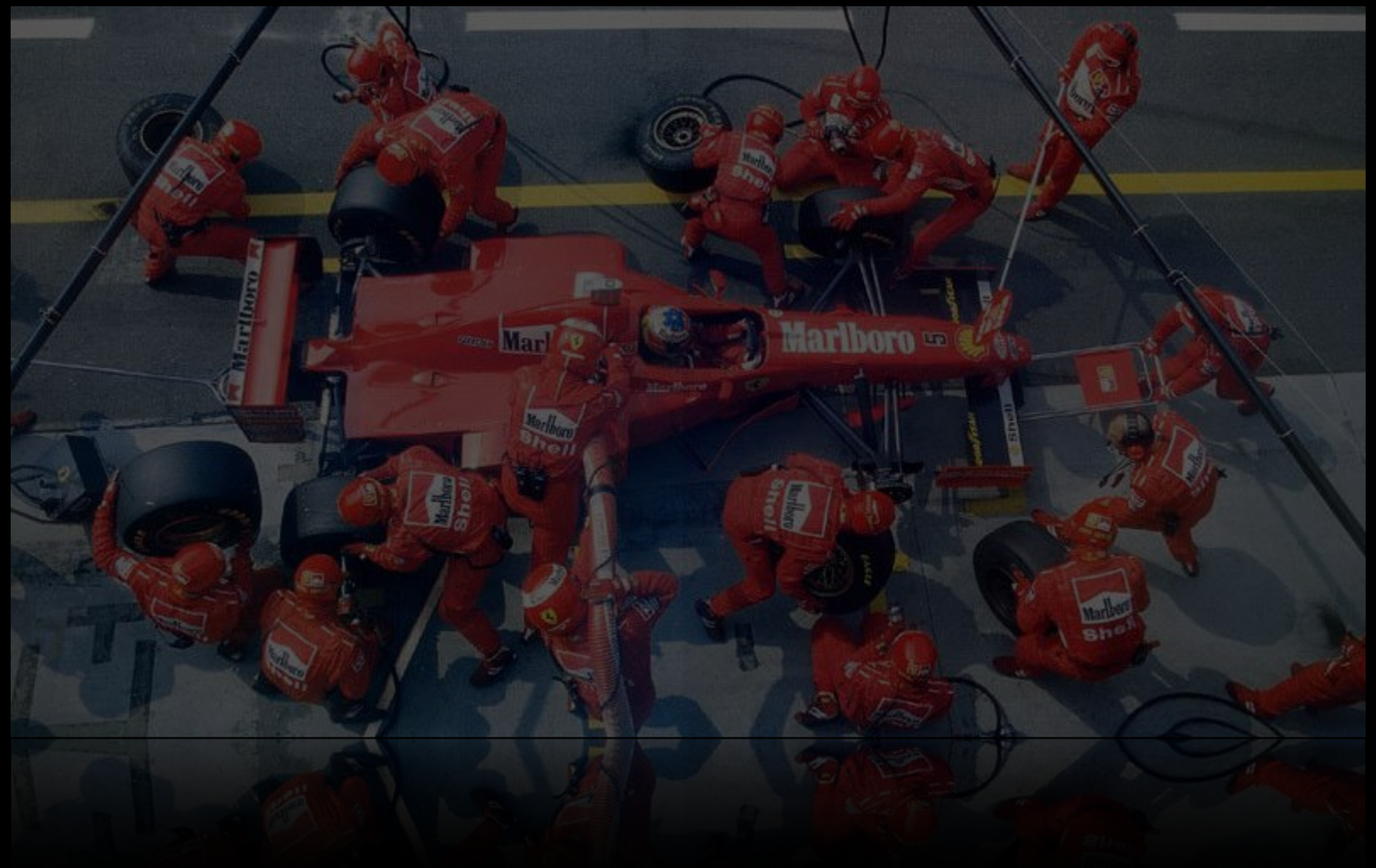
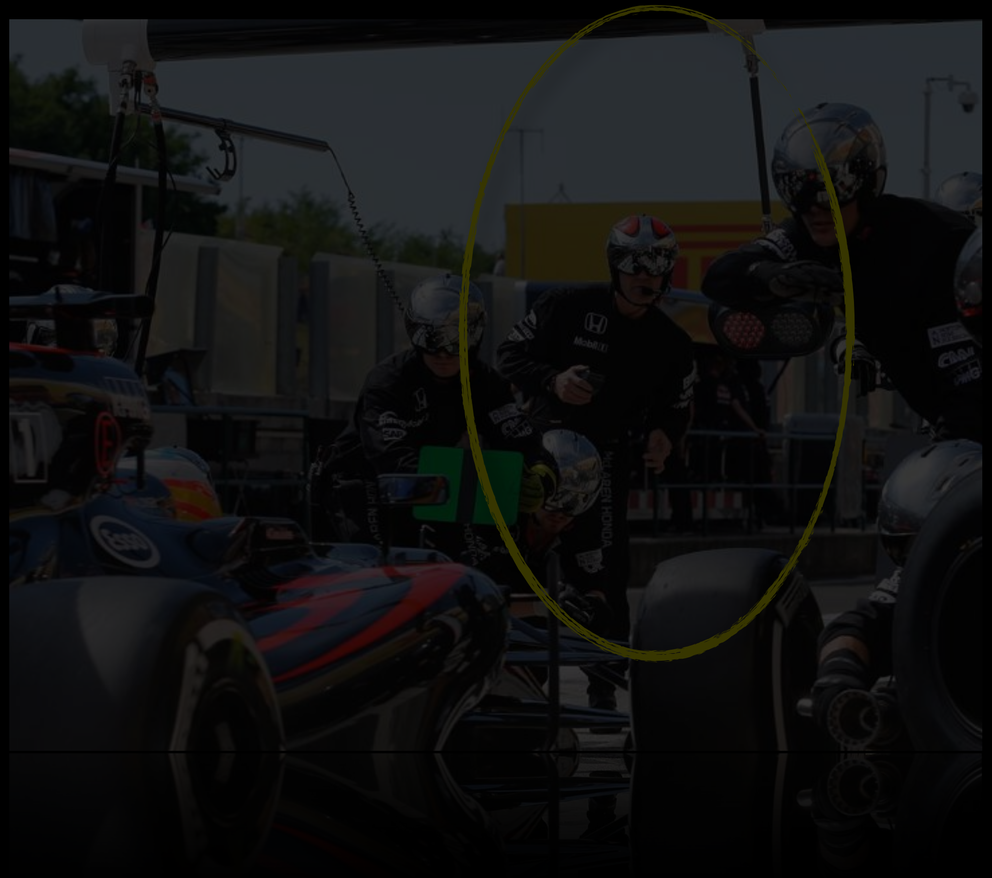
leadership

anaesthetist ➡ intensivist





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task sequence

clear rhythm, defined order

task sequence

clear rhythm, defined order

task sequence

clear rhythm, defined order

inconsistent and non-sequential

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task sequence

clear rhythm, defined order

Three Logical Phases

1. equipment and technology
2. information
3. discussion and plan

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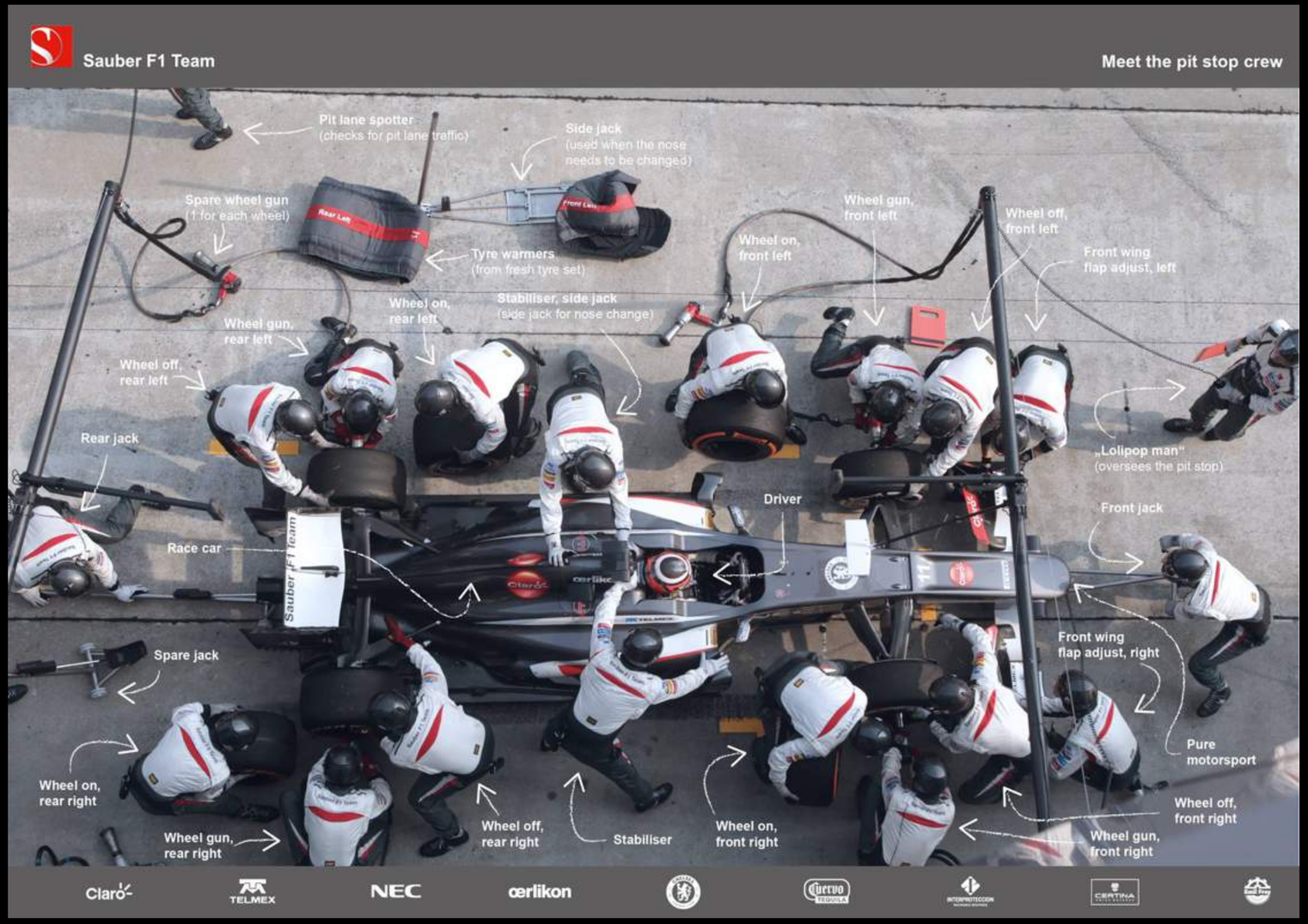
task allocation



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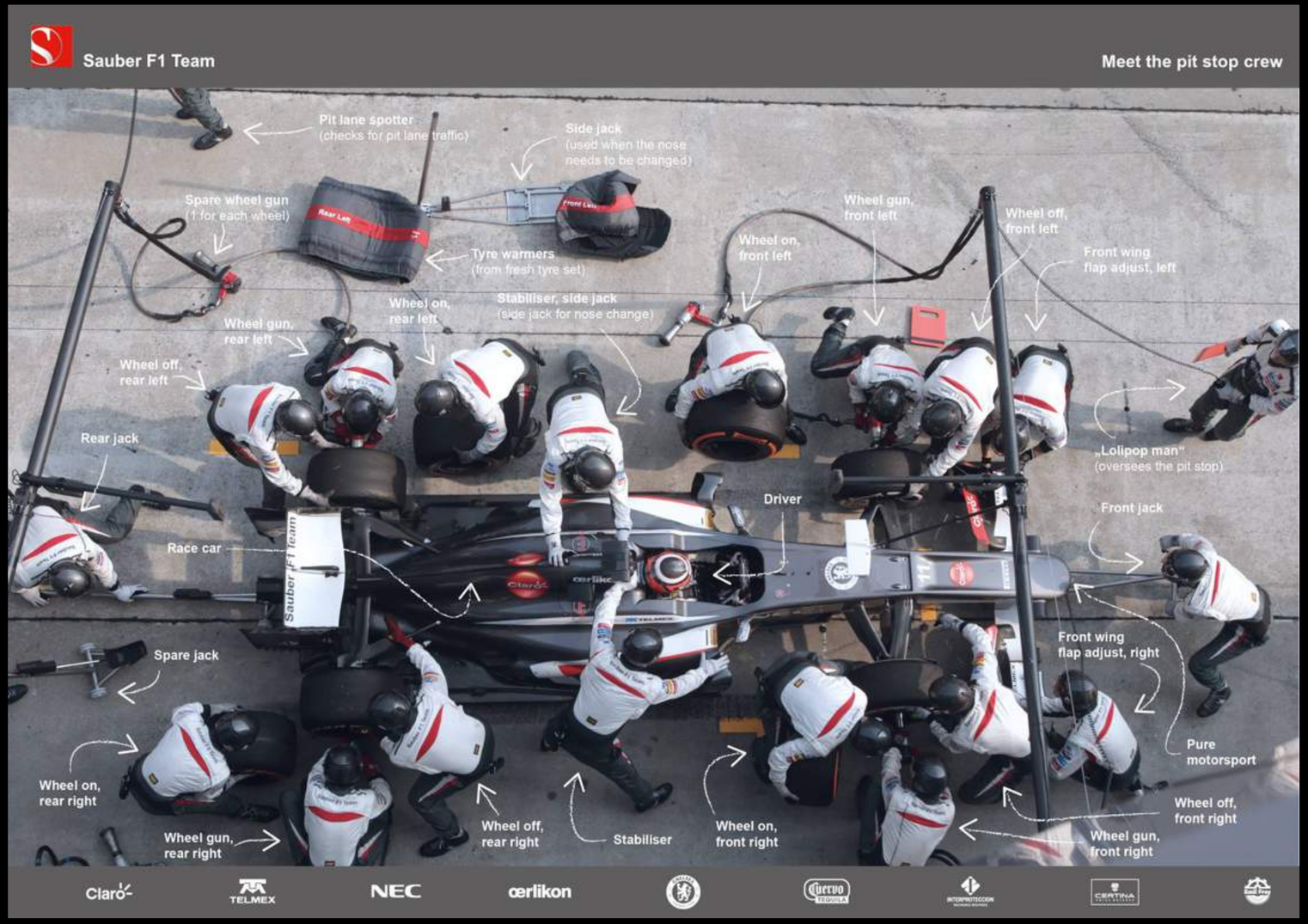
task allocation



erratic and informal

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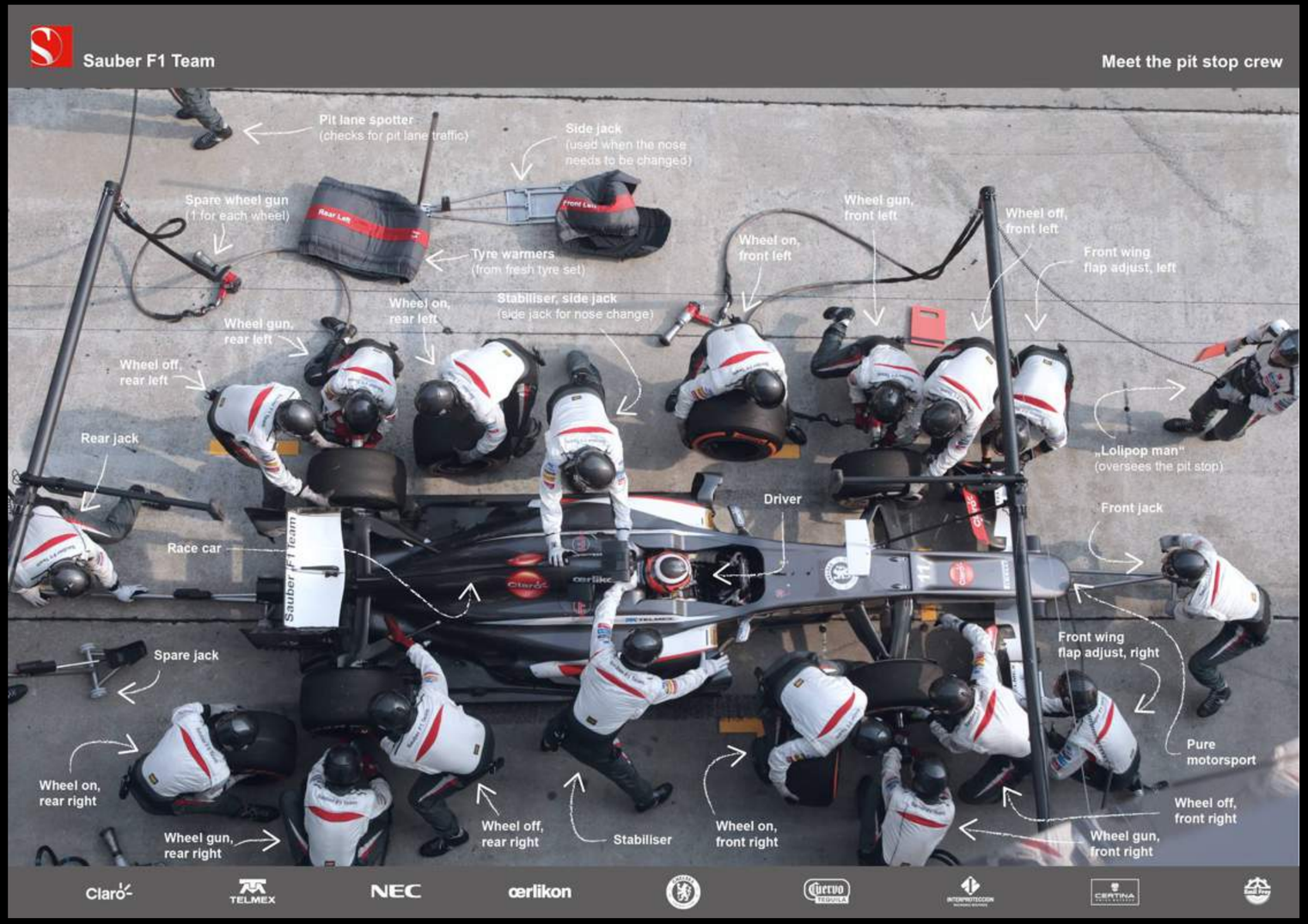
task allocation



specific roles allocated

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predicting and planning

FMEA

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predicting and planning

FMEA

severity (S) or effect

occurrence (O) or likelihood

detection (D) or effectiveness

Risk Priority Number (RPN)

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predicting and planning

FMEA

severity (S) or effect

occurrence (O) or likelihood

detection (D) or effectiveness

Risk Priority Number (RPN)

S x O x D = RPN

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predicting and planning

FMEA

informal inconsistent risk assessment

severity (S) or effect

occurrence (O) or likelihood

detection (D) or effectiveness

Risk Priority Number (RPN)

S x O x D = RPN

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predicting and planning

FMEA

severity (S) or effect

occurrence (O) or likelihood

detection (D) or effectiveness

Risk Priority Number (RPN)

S x O x D = RPN

application of FMEA

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predicting and planning

FMEA

severity (S) or effect

occurrence (O) or likelihood

detection (D) or effectiveness

Risk Priority Number (RPN)

S x O x D = RPN

application of FMEA

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discipline and composure

minimal speech, calm demeanour

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discipline and composure

many simultaneous conversations

minimal speech, calm demeanour

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discipline and composure

minimal speech, calm demeanour

limited and structured communication

discipline and composure

minimal speech, calm demeanour

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checklists

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checklists

did not exist

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checklists

became mandatory

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speaking up

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speaking up

fear of speaking up

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speaking up

positive encouragement to speak up

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briefing

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briefing

good

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briefing

better

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situational awareness

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situational awareness

no-one watching the big picture

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situational awareness

anaesthetist and intensivist share role

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training and repetition

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training and repetition

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training and repetition

not practiced

training and repetition

rehearsed, practiced
and, for new staff,
at induction

debrief and review

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debrief and review

not debriefed

debrief and review

all perfomance monitored,
handovers analysed weekly

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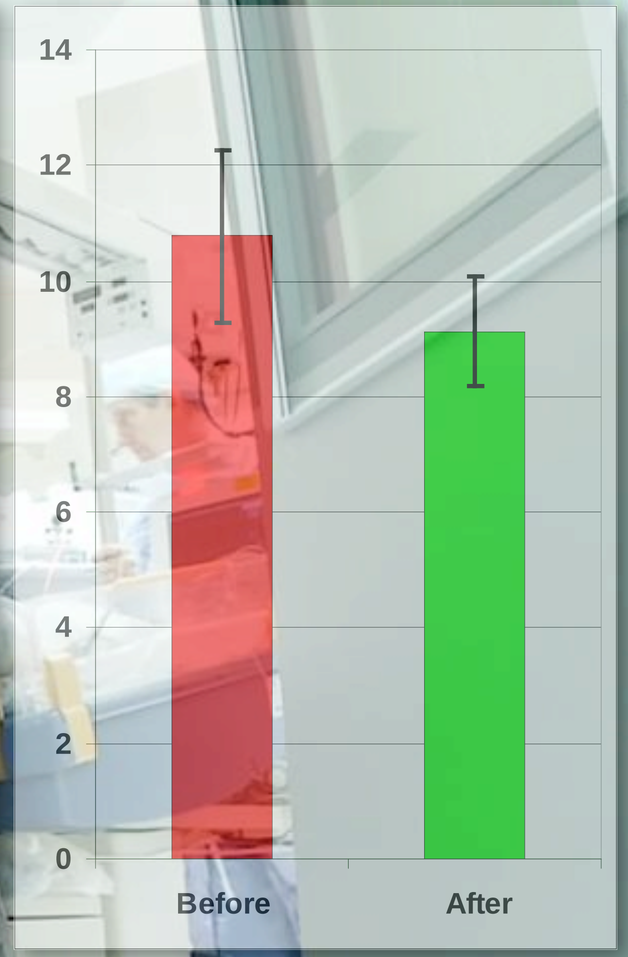
7
6
5
4
3
2
1
0
Before
After
Number of Errors
4
3
2
1
0
Before
After
Information Omissions
14
12
10
8
6
4
2
0
Before
After
Duration (mins)

7
6
5
4
3
2
1
0
Before
After
Number of Errors
4
3
2
1
0
Before
After
Information Omissions
14
12
10
8
6
4
2
0
Before
After
Duration (mins)

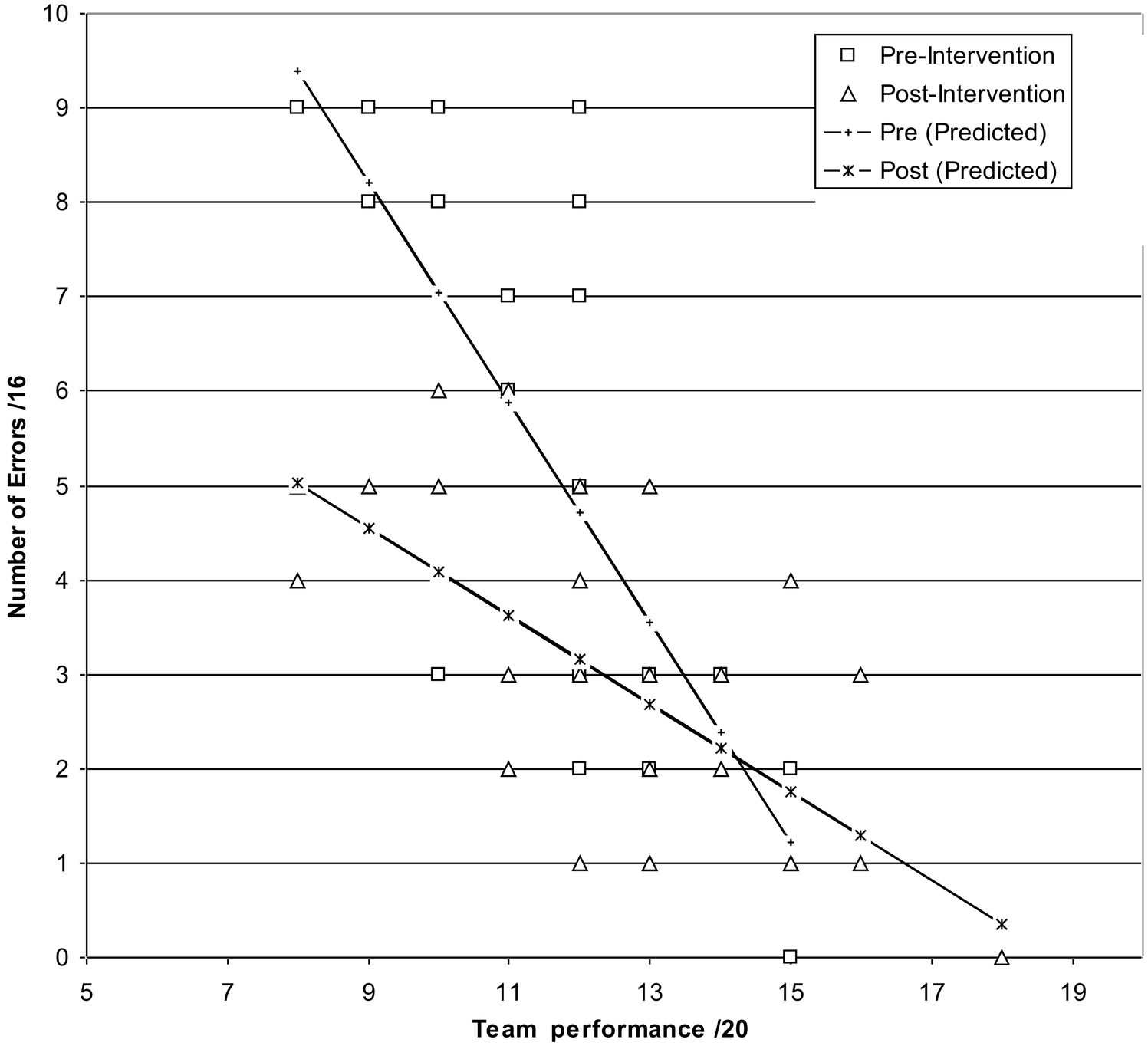
Number of Errors

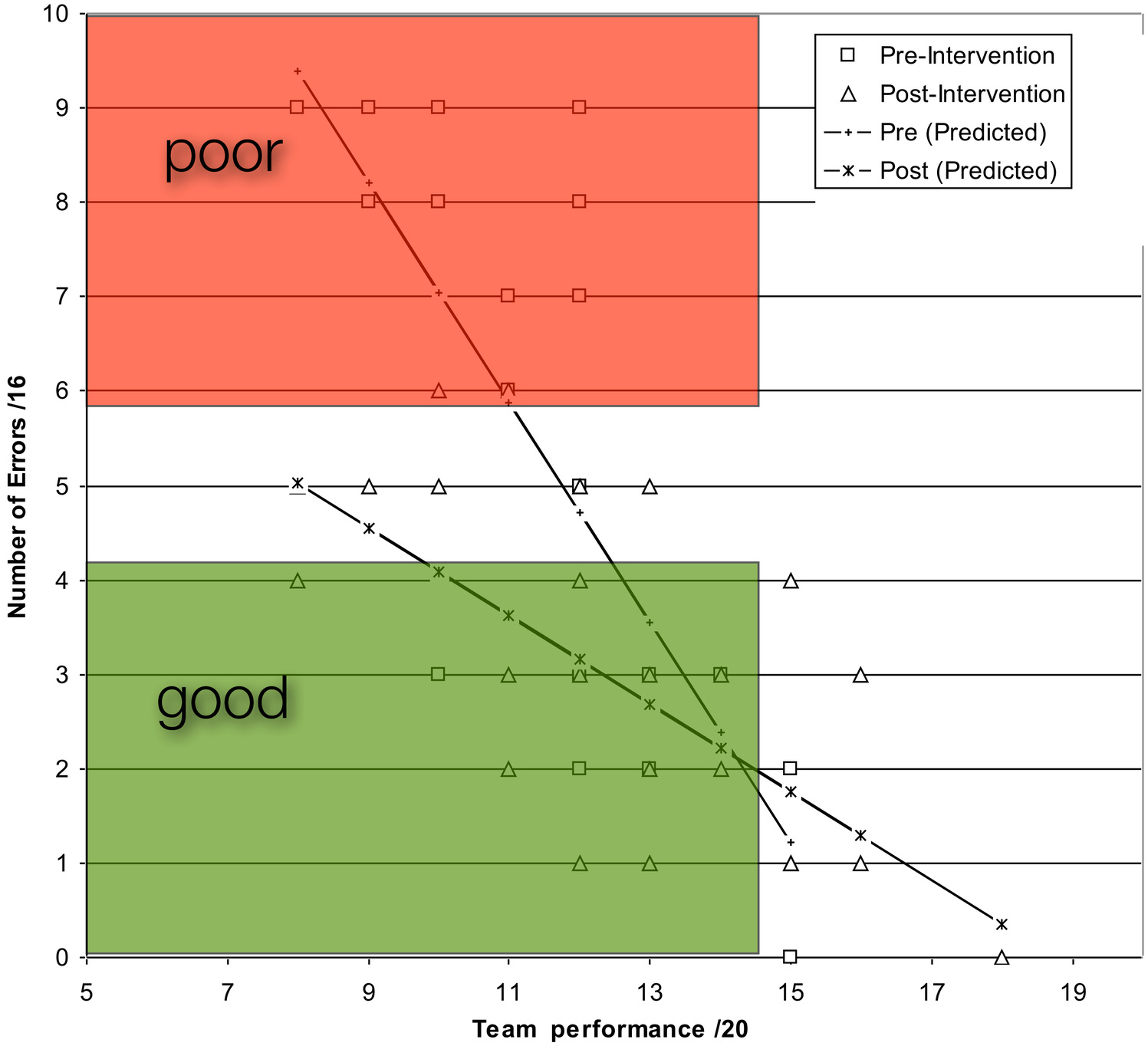
Information Omissions

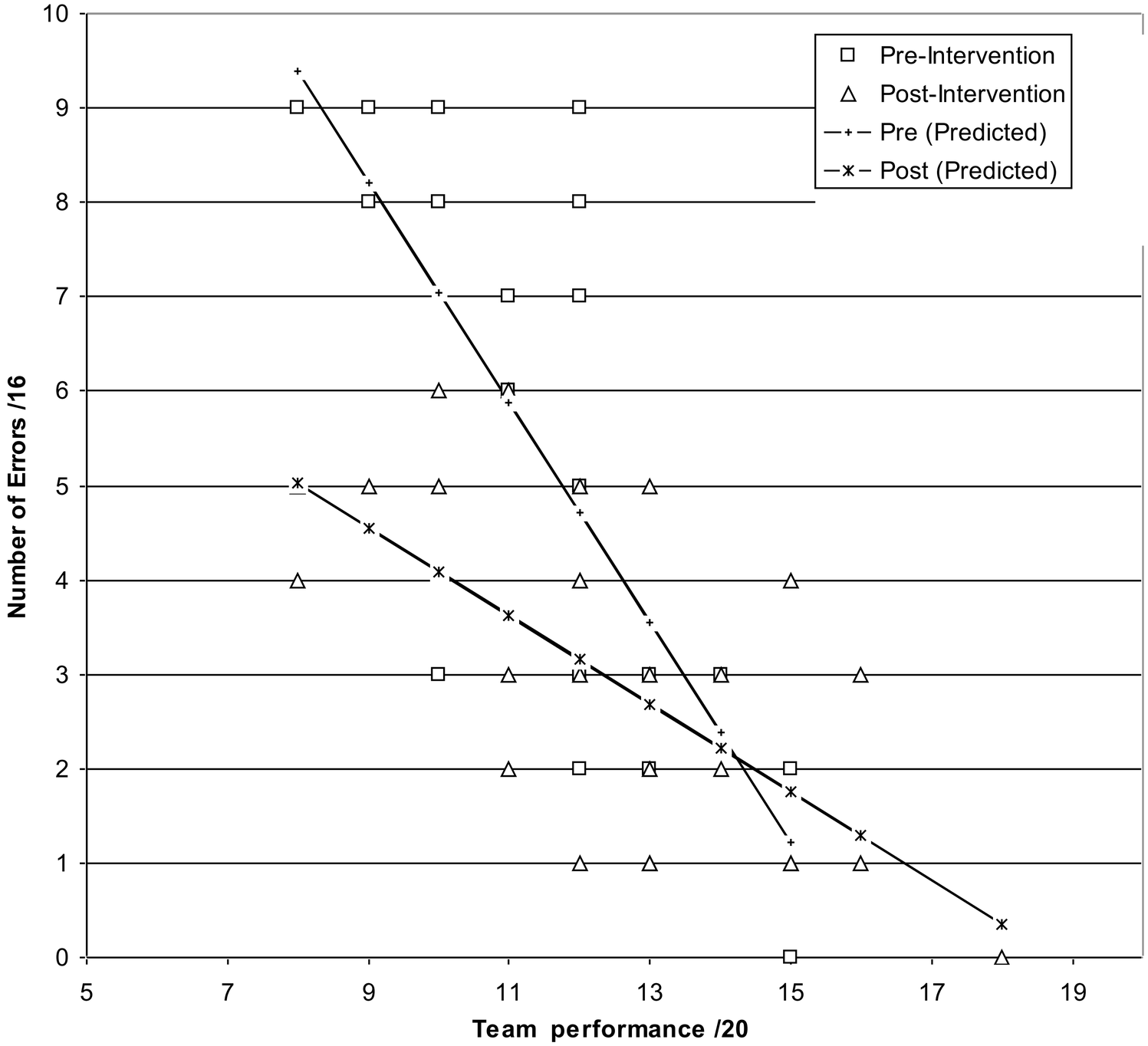


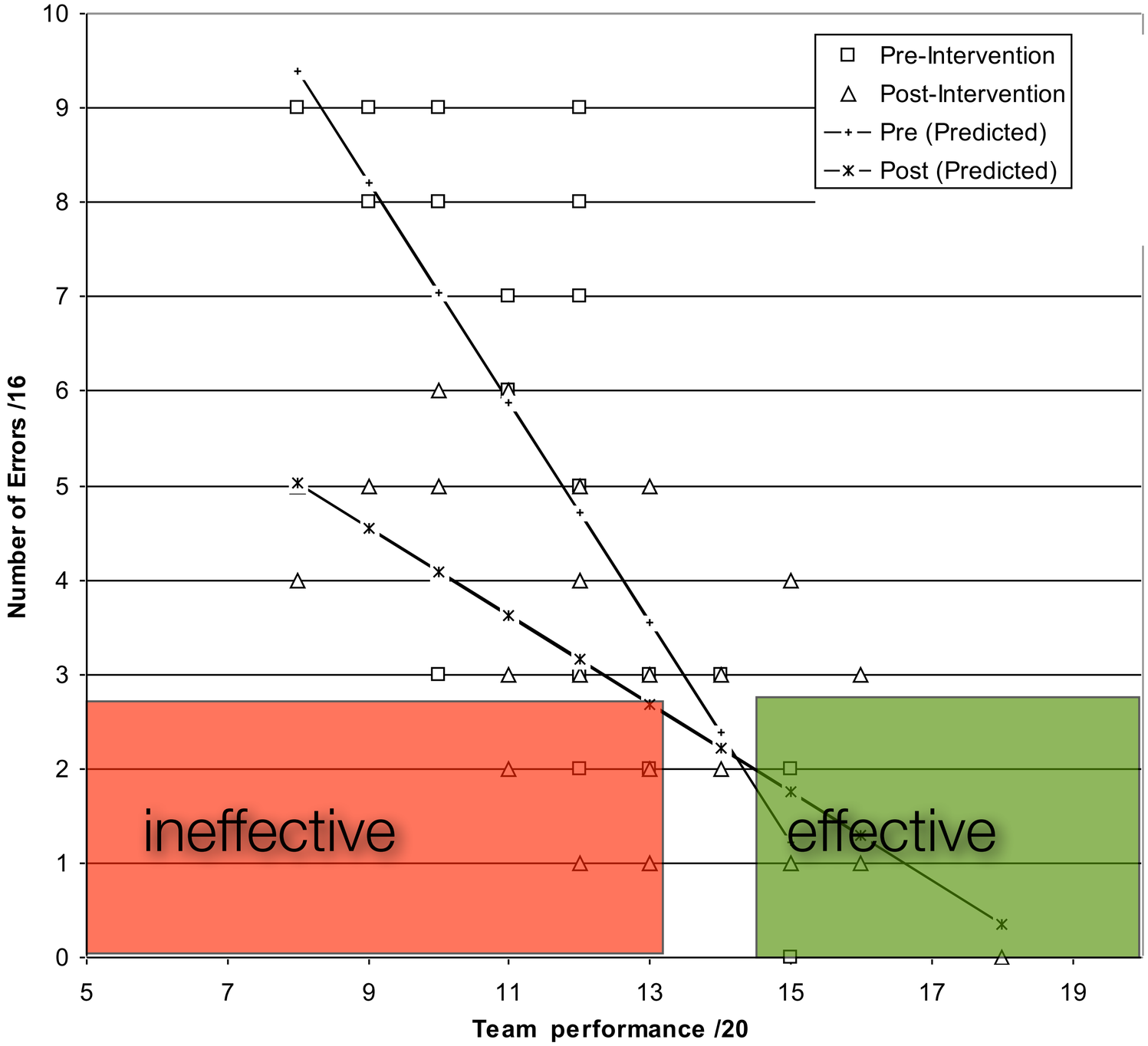
Duration (mins)

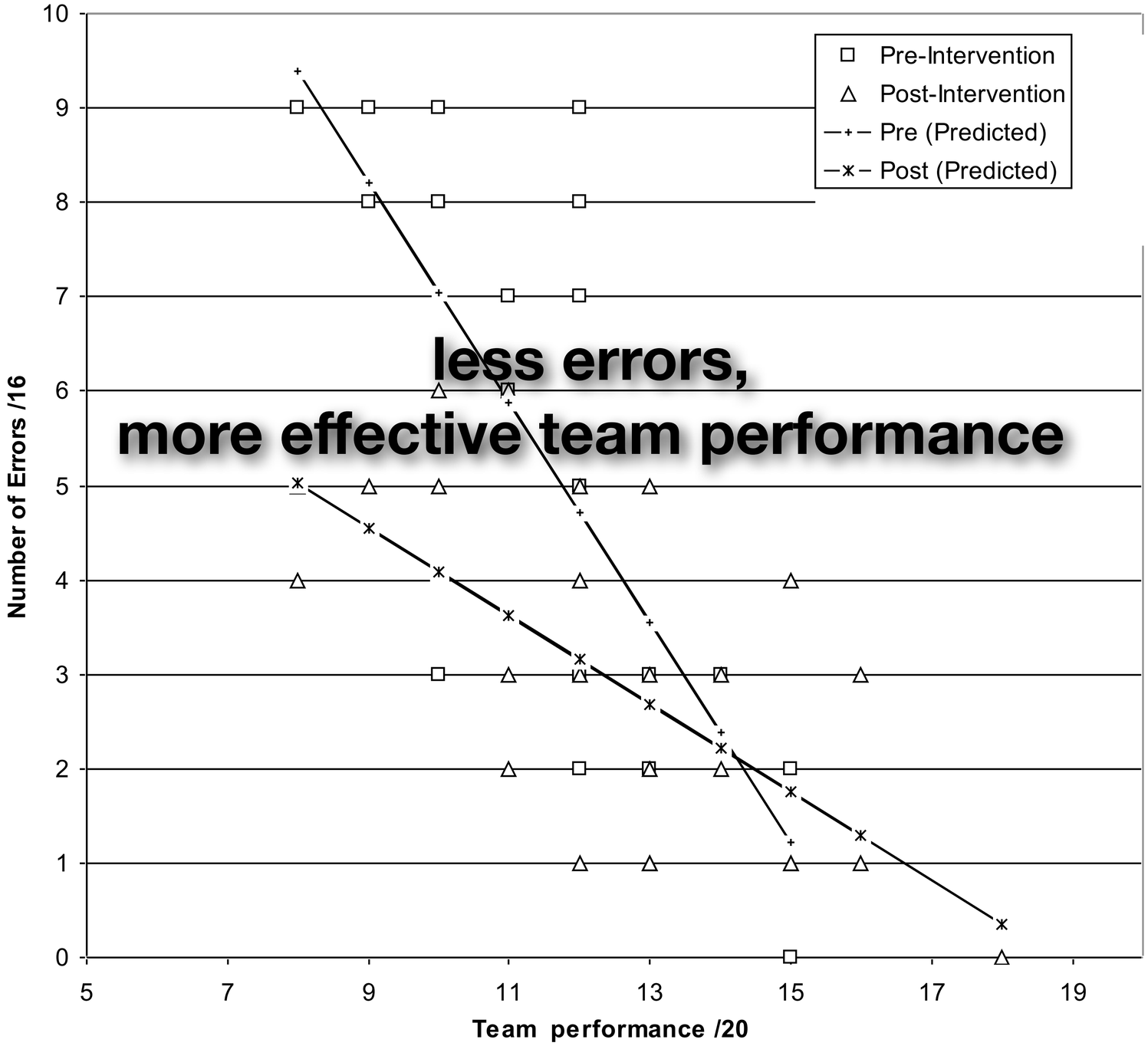
x 4 reduction in multiple errors


Pre-Intervention
Post-Intervention
Pre (Predicted)
Post (Predicted)
Number of Errors /16
Team performance /20
0
1
2
3
4
5
6
7
8
9
10
5
7
9
11
13
15
17
19


poor
good
Pre-Intervention
Post-Intervention
Pre (Predicted)
Post (Predicted)
Number of Errors /16
Team performance /20
0
1
2
3
4
5
6
7
8
9
10
5
7
9
11
13
15
17
19


Pre-Intervention
Post-Intervention
Pre (Predicted)
Post (Predicted)
Number of Errors /16
Team performance /20
0
1
2
3
4
5
6
7
8
9
10
5
7
9
11
13
15
17
19


Pre-Intervention
Post-Intervention
Pre (Predicted)
Post (Predicted)
Number of Errors /16
Team performance /20
ineffective
effective
0
1
2
3
4
5
6
7
8
9
10
5
7
9
11
13
15
17
19


Pre-Intervention
Post-Intervention
Pre (Predicted)
Post (Predicted)
Number of Errors /16
Team performance /20
0
1
2
3
4
5
6
7
8
9
10
5
7
9
11
13
15
17
19
less errors,
more effective team performance

Pediatric Anesthesia 2007 **17**: 470–478 doi:10.1111/j.1460-9592.2007.02239.x

Patient handover from surgery to intensive care: using Formula 1 pit-stop and aviation models to improve safety and quality

KEN R. CATCHPOLE PhD*, MARC R. DE LEVAL MD†, ANGUS MCEWAN FRCA‡, NICK PIGOTT FRCPCH§, MARTIN J. ELLIOTT MD, FRCS¶, ANNETTE MCQUILLAN BSC†, CAROL MACDONALD BSC† AND ALLAN J. GOLDMAN§

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LEADER (U.S.) | NEW FORMULA

A Hospital Races To Learn Lessons Of Ferrari Pit Stop

Auto Crew Teaches Surgeons Small Errors Can Add Up On the Track, or in the ICU

By **GAUTAM NAIK**

Updated Nov. 14, 2006 12:01 a.m. ET

Allan Goldman

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what they have learned from us

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what they have learned from us

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earlier talent discovery

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earlier talent discovery

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earlier talent discovery

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3 biggest

lessons

from

F1

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3 biggest

lessons

from

F1

rehearsal

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3 biggest

lessons

from

F1

rehearsal

rehearsal

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3 biggest

lessons

from

F1

rehearsal

rehearsal

rehearsal

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safety

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Hans Herrmann 1959
AVUS German Grand Prix

Cliff Allison 1960
Monaco

safety

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motor racing is dangerous

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Le Mans 1955

motor racing is dangerous

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FIRE!

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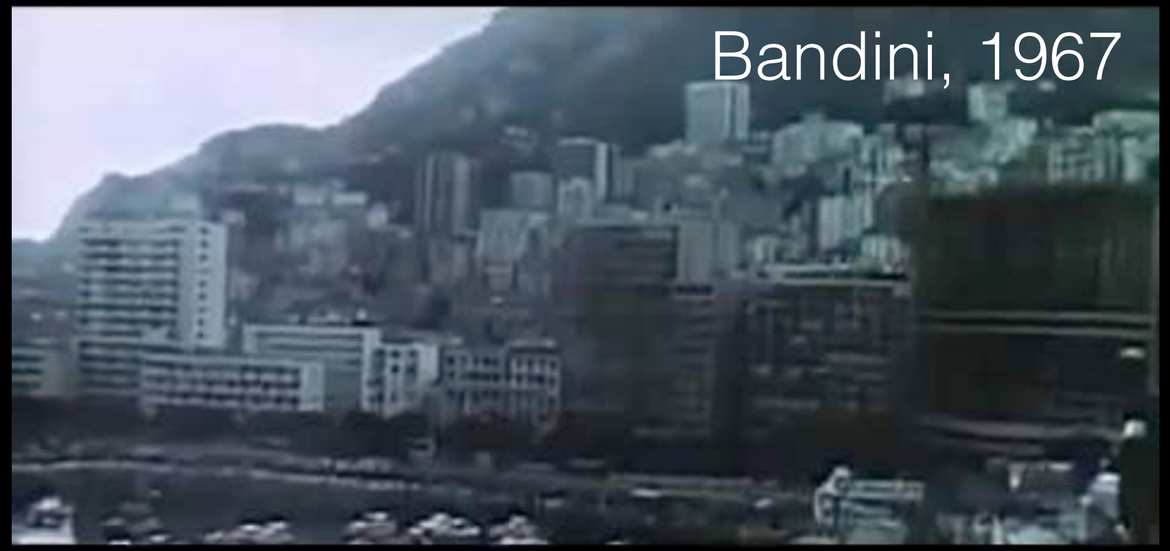
FIRE!



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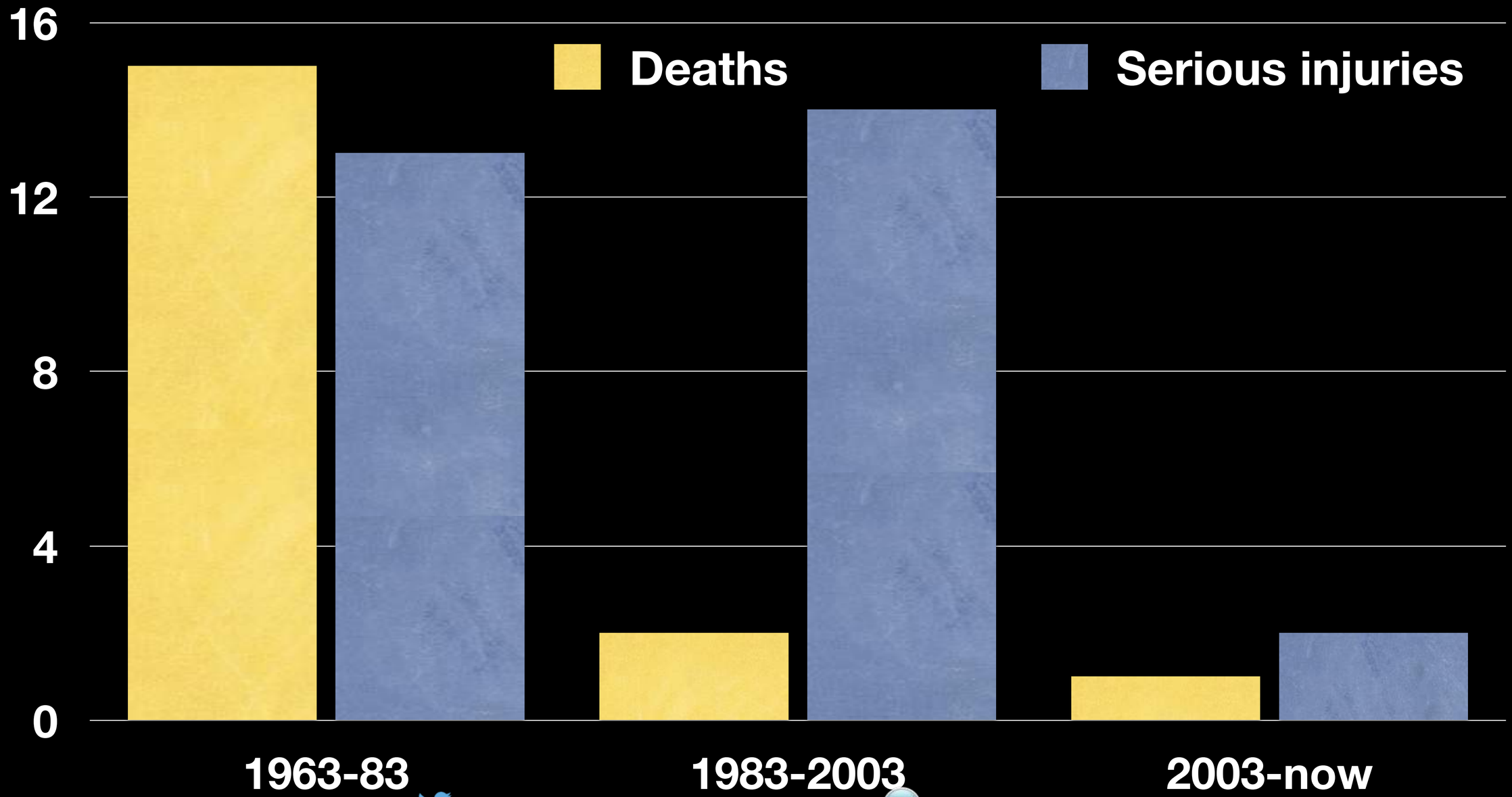
Deaths and Injuries in F1



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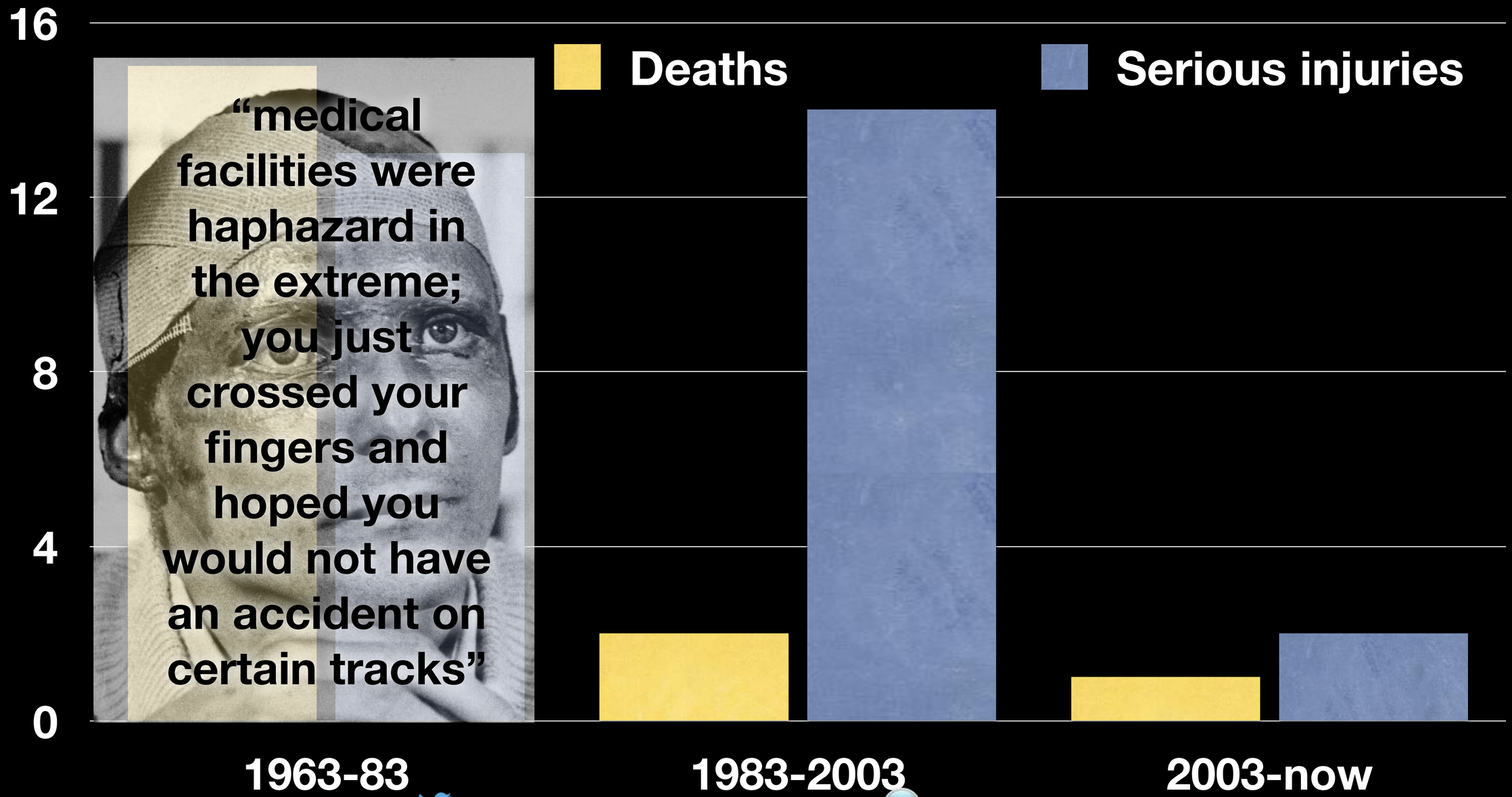
Deaths and Injuries in F1



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Imola 1994

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martin.elliott@gosh.nhs.uk

Rubens Barrichello

Imola 1994

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martin.elliott@gosh.nhs.uk

Rubens Barrichello

Roland Ratzenberger

Imola 1994

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Rubens Barrichello

Roland Ratzenberger

Ayrton Senna

Imola 1994

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Rubens Barrichello

Roland Ratzenberger

Ayrton Senna

Imola 1994

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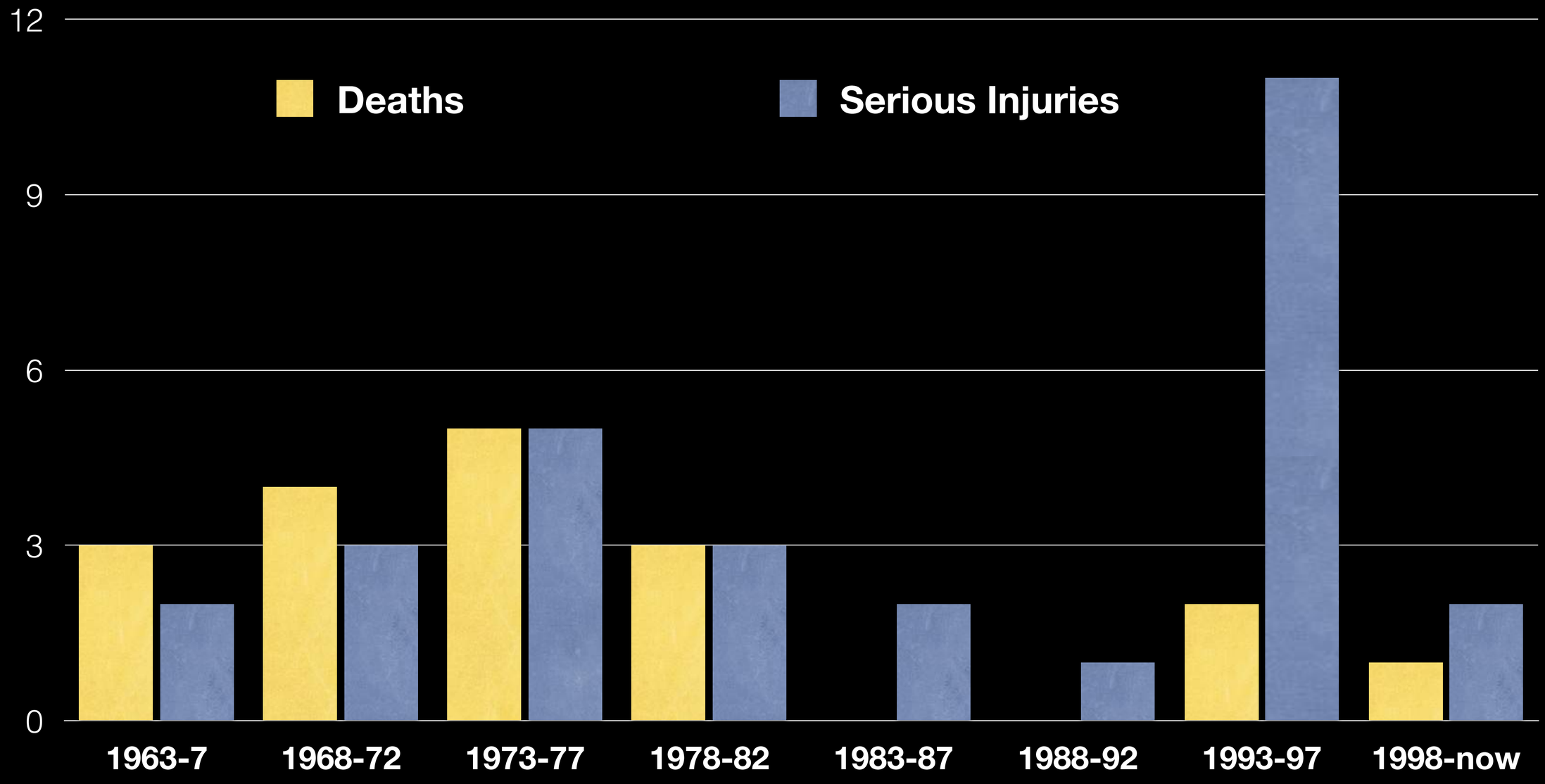
Deaths and Injuries in Formula 1



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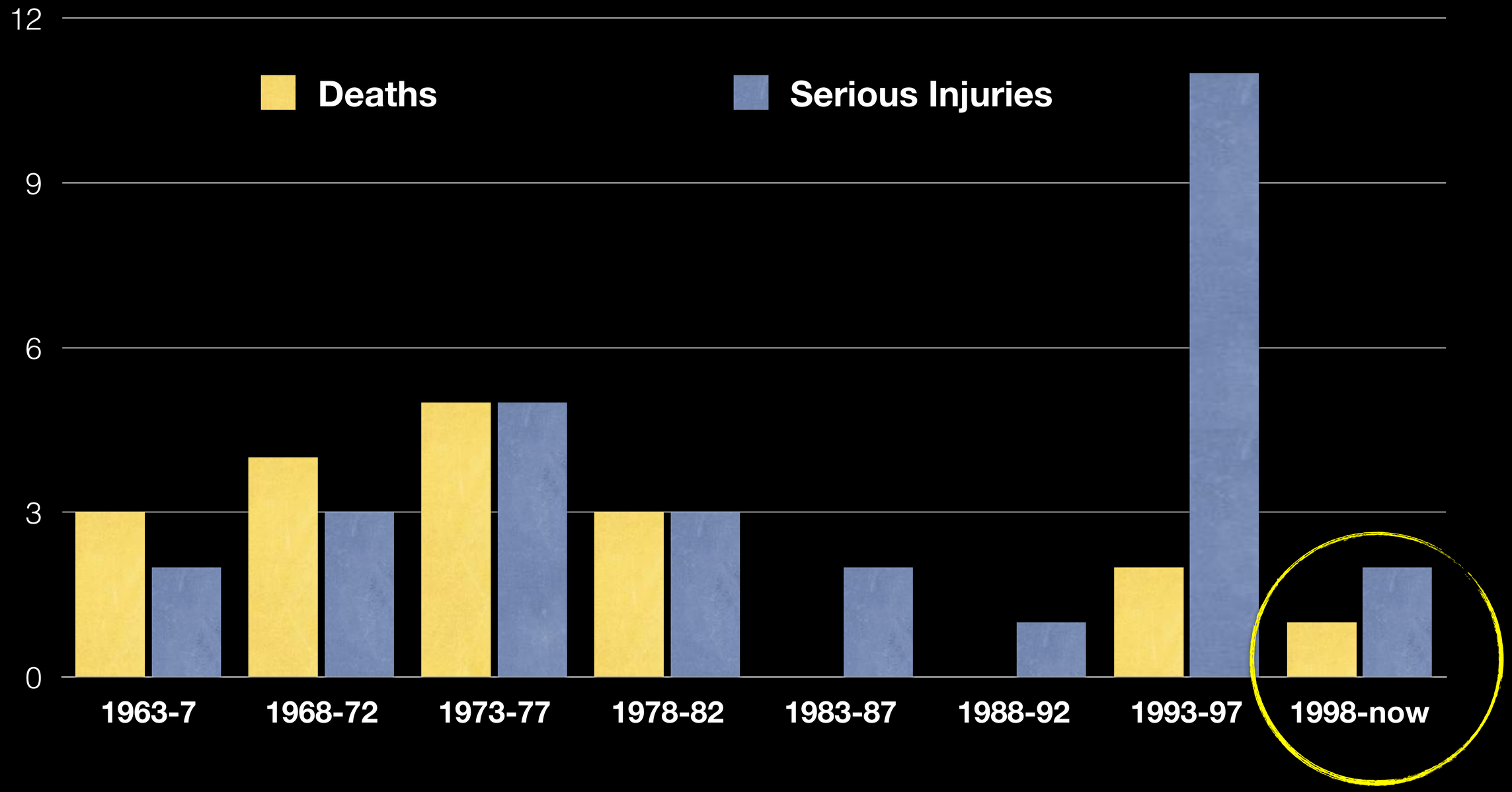
Deaths and Injuries in Formula 1



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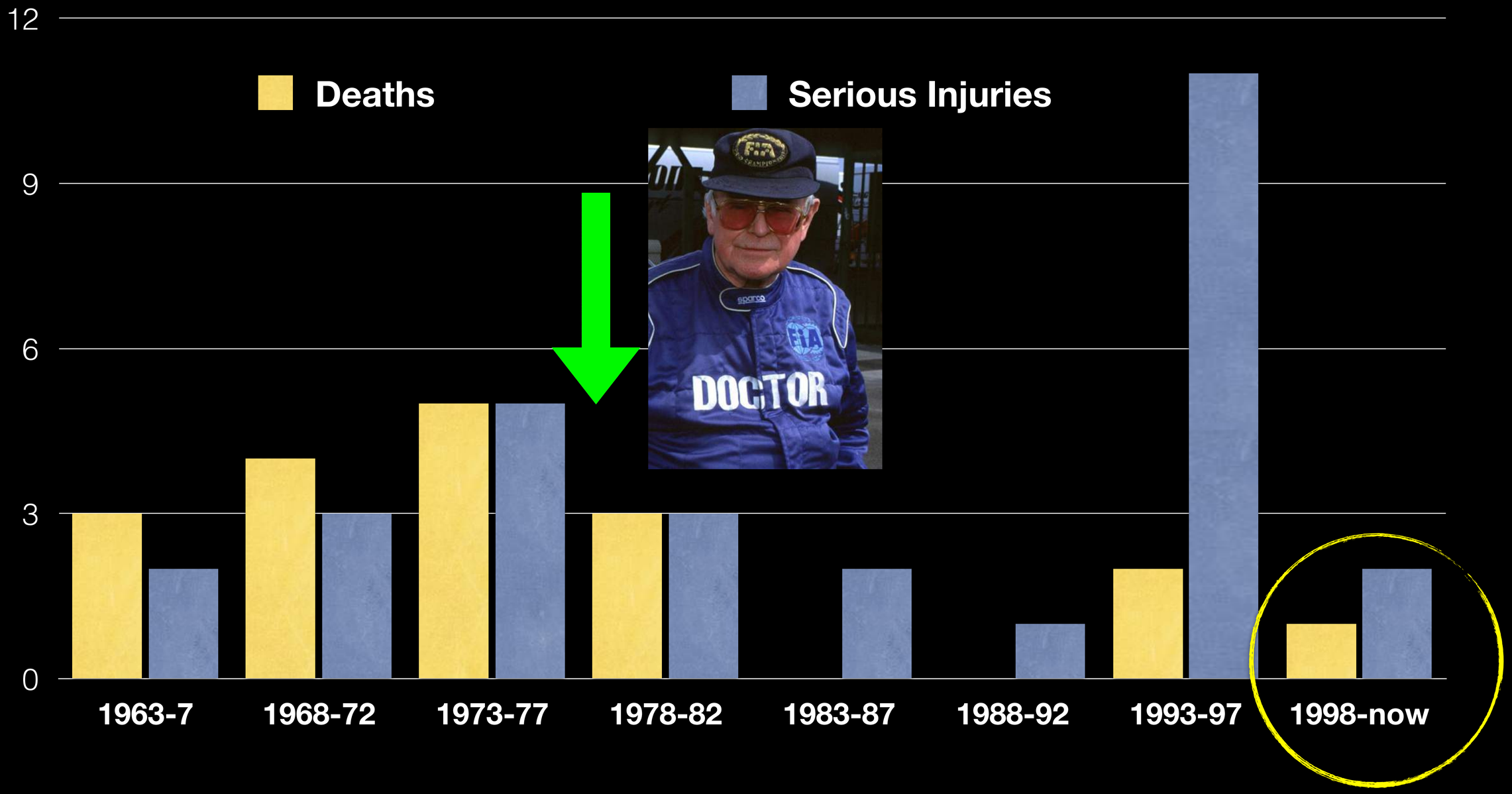
Deaths and Injuries in Formula 1



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Jules Bianchi 2014

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Jules Bianchi 2014

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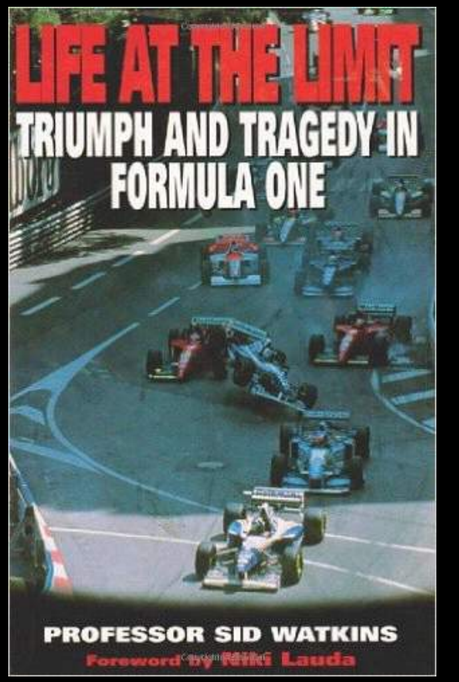

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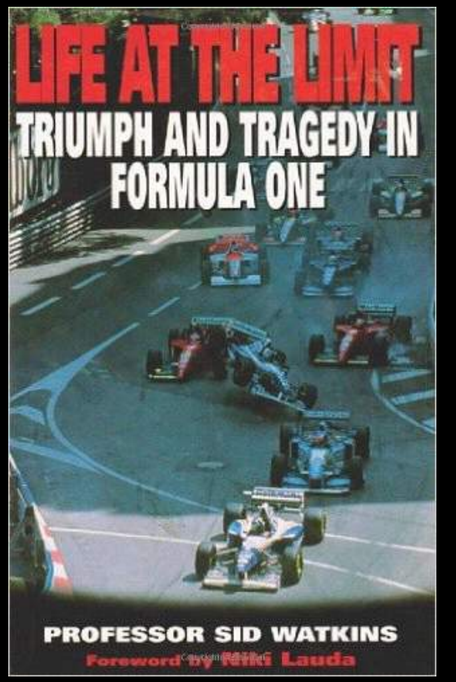

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Formula One remains **Dangerous**

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martin.elliott@gosh.nhs.uk

Formula One remains **Dangerous**

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martin.elliott@gosh.nhs.uk

Formula One remains **Dangerous**

but they have made it much **safer**

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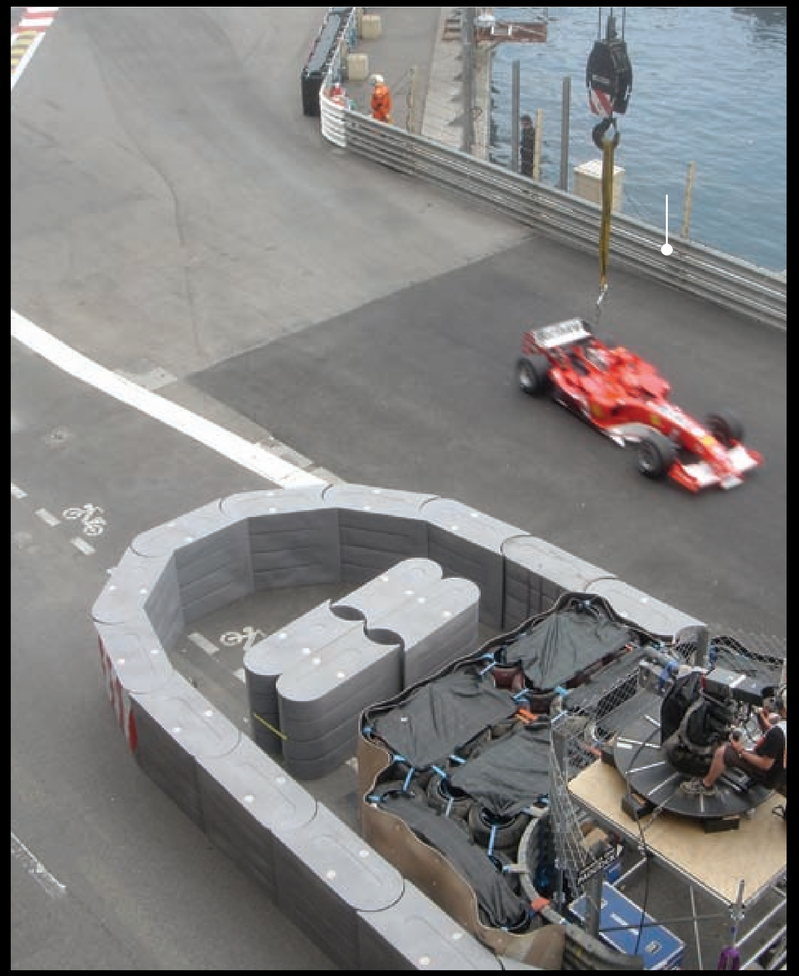
martin.elliott@gosh.nhs.uk

TECPRO BARRIERS®

Protected by Patent



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TECPRO BARRIERS®

Protected by Patent

Carlos Sainz,
Sochi 2015

Romain Grosjean
Sochi 2015

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@ProfMJElliott

martin.elliott@gosh.nhs.uk

passenger protection cages

seat belts

disc brakes

regenerative braking

safer fuel tanks

aerodynamics

electronics & sensors

better fuels

stronger, lighter materials

less engine friction

better tyres

better suspension

comfort
reliability
speed
efficiency
safety
automation

health?

@ProfMJElliott

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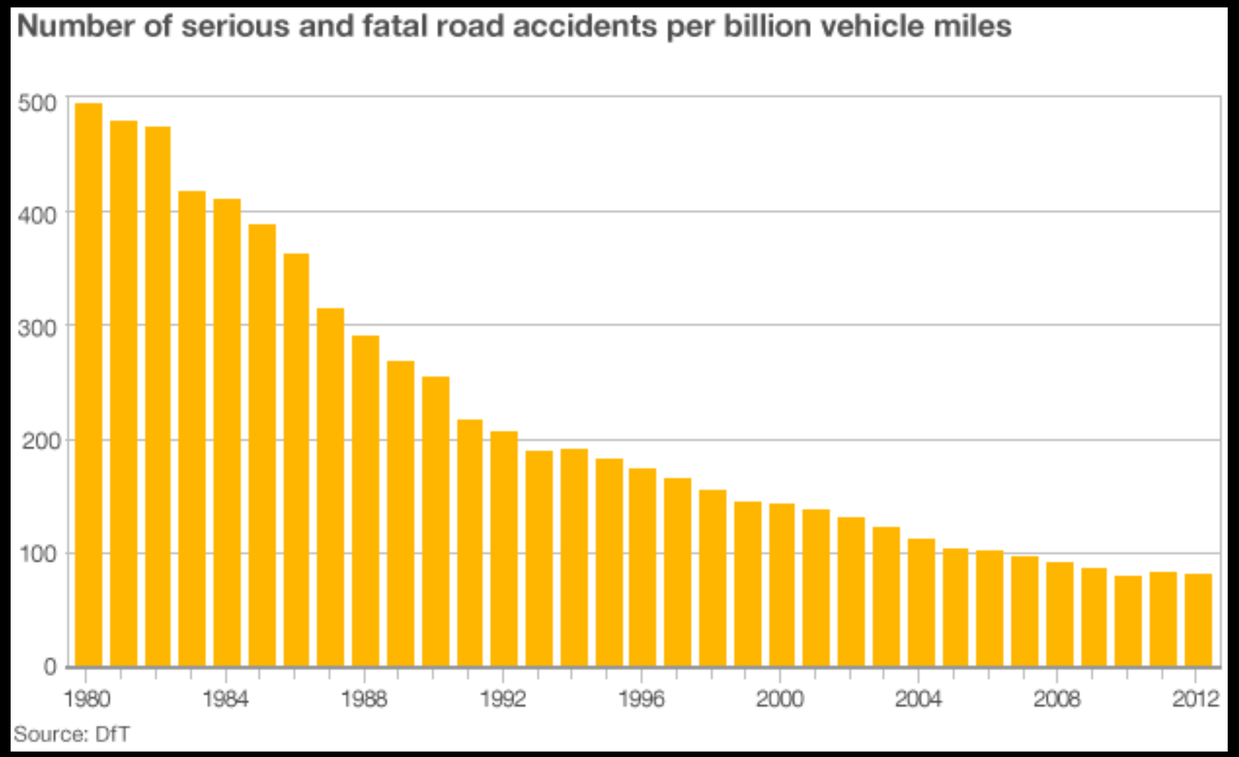

safer cars, safer roads, less harm

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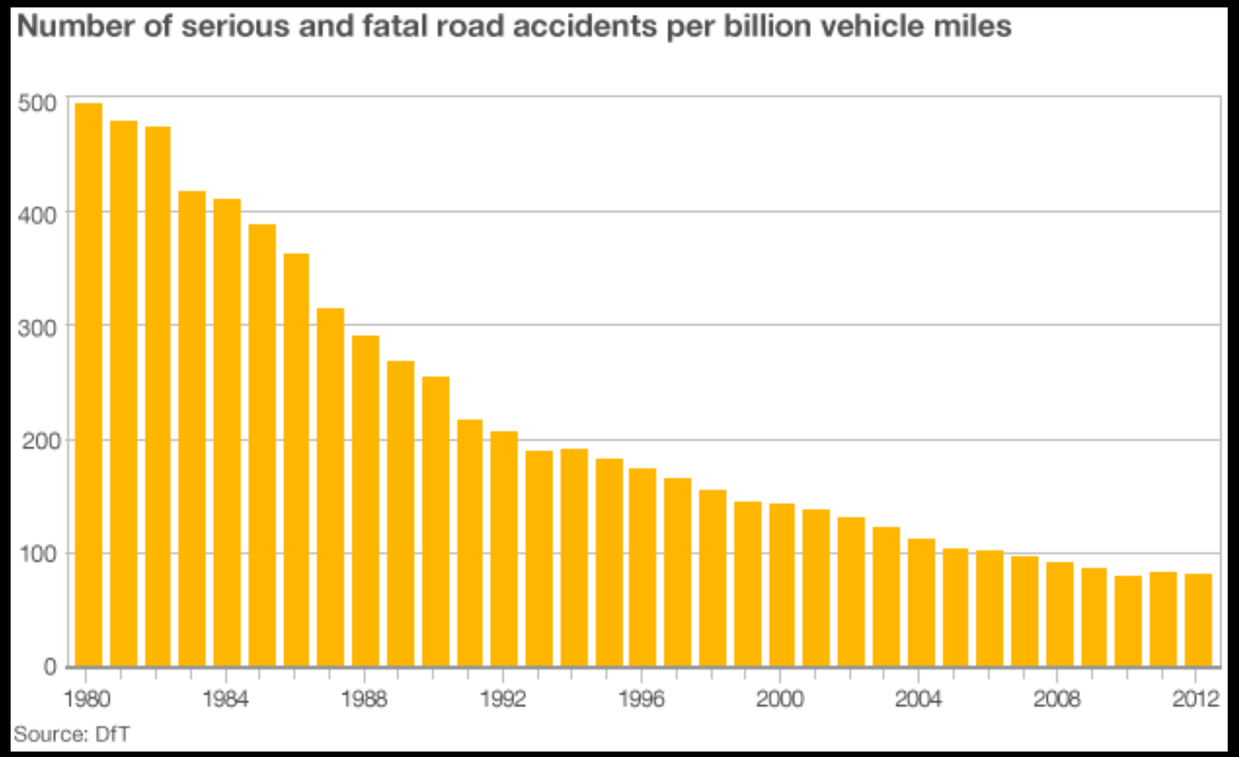

safer cars, safer roads, less harm

but less hearts to transplant

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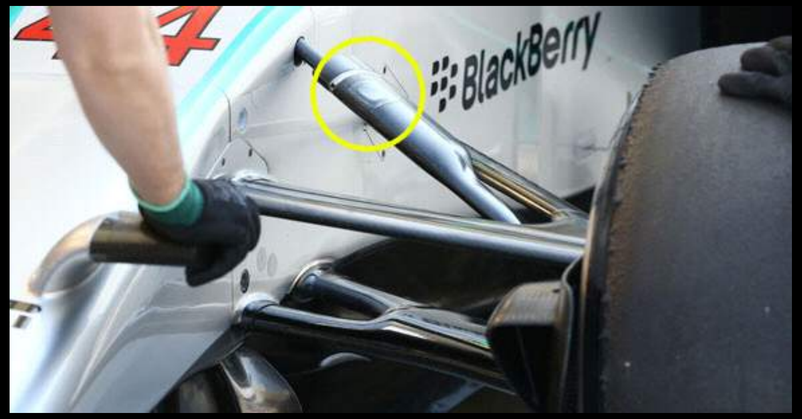
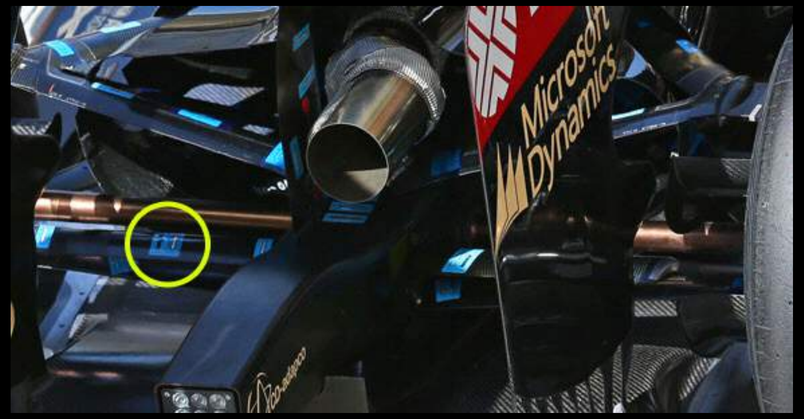
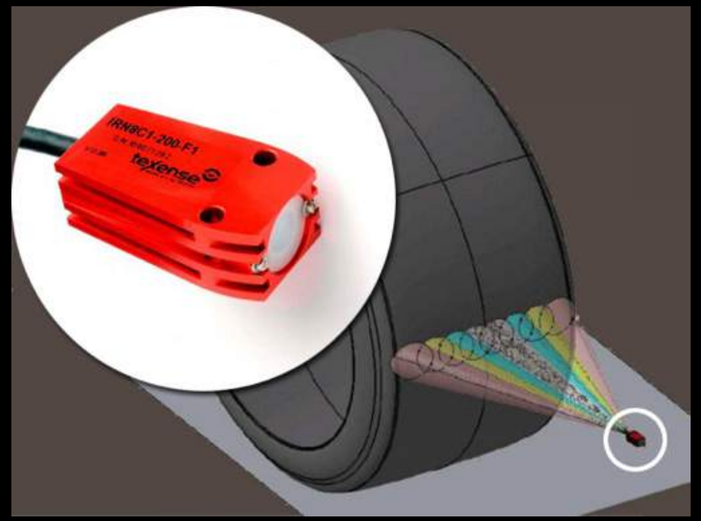
DATA
JOHNNIE WALKER
McLAREN HONDA







sensors

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BIG DATA IN FORMULA ONE

Formula One cars generate **terabytes of data** during a race. Dozens of engineers at the track and as far away as the U.K. comb over the data during a race in near real-time, looking for any adjustment that could **win or lose** a race.

RACE TEAMS COMBINED TO GENERATE **243 TERABYTES** OF DATA FROM THEIR VEHICLES AT THE 2014 U.S. GRAND PRIX IN AUSTIN, TX.

243 TERABYTES OF DATA COMPARED TO ...

243 TB

http://www.forbes.com/sites/frankbi/2014/11/13/how-formula-one-teams-are-using-big-data-to-get-the-inside-edge/

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RACE TEAMS COMBINED TO GENERATE 243 TERABYTES OF DATA FROM THEIR VEHICLES AT THE 2014 U.S. GRAND PRIX IN AUSTIN, TX.

243 TERABYTES OF DATA COMPARED TO ...

EQUIPPED WITH HUNDREDS OF SENSORS, F1 CARS PROVIDE A STREAM OF DATA THAT'S ANALYZED THOUSANDS OF MILES AWAY IN NEAR REAL-TIME

.170 secs
Round trip for race data to transfer between UK and U.S.

.300 secs
Round trip for race data to transfer between UK and Australia

.600 secs
Difference between 1st and 2nd place at 2014 Spanish Grand Prix

1.923 secs
World record fastest F1 pitstop, set by Red Bull in Austin 2013

http://www.forbes.com/sites/frankbi/2014/11/13/how-formula-one-teams-are-using-big-data-to-get-the-inside-edge/

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SAP HANA Monitoring

http://stillbrandworks.com/sap/pit-wall/

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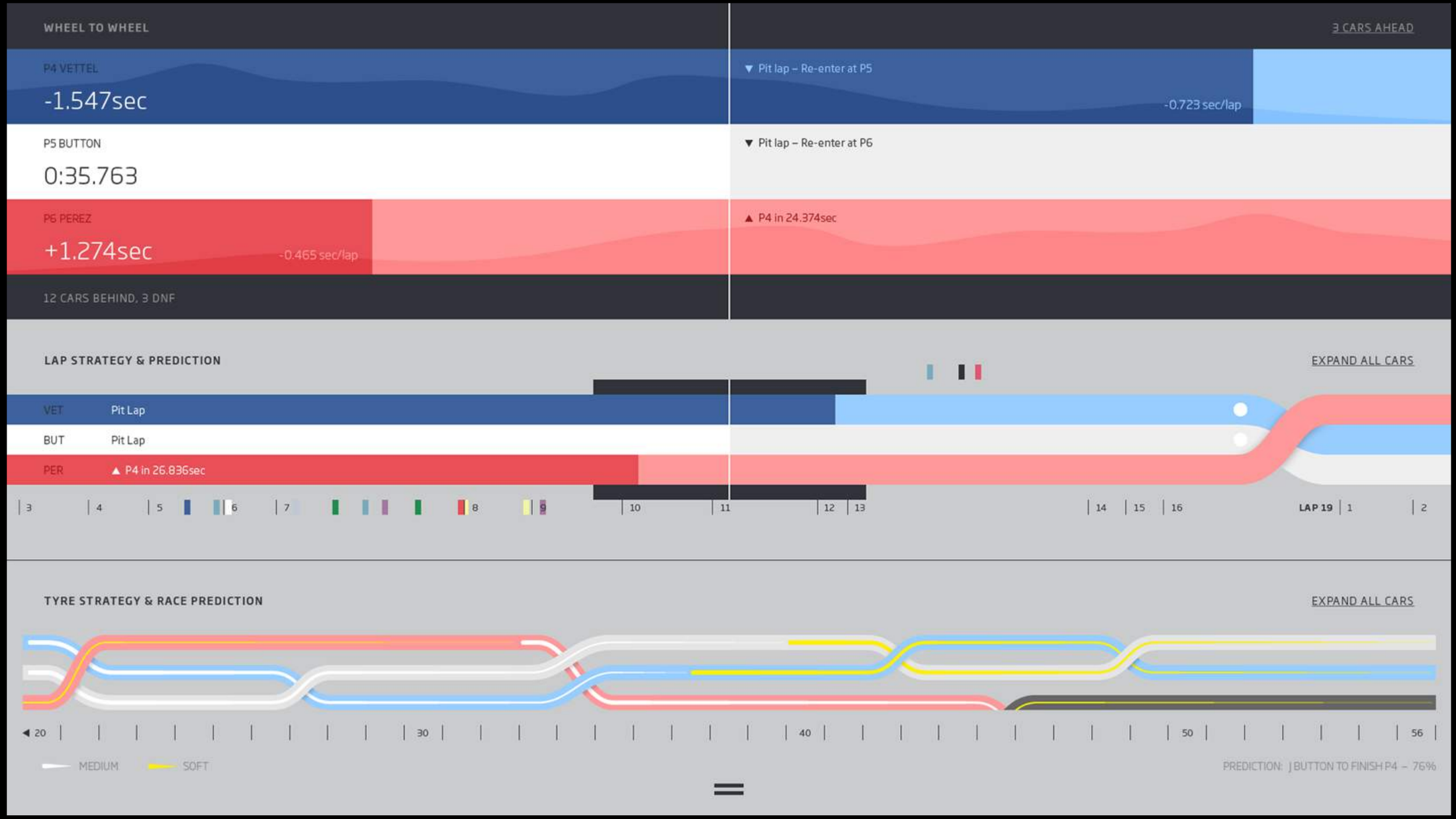
SAP HANA Strategy

http://stillbrandworks.com/sap/pit-wall/



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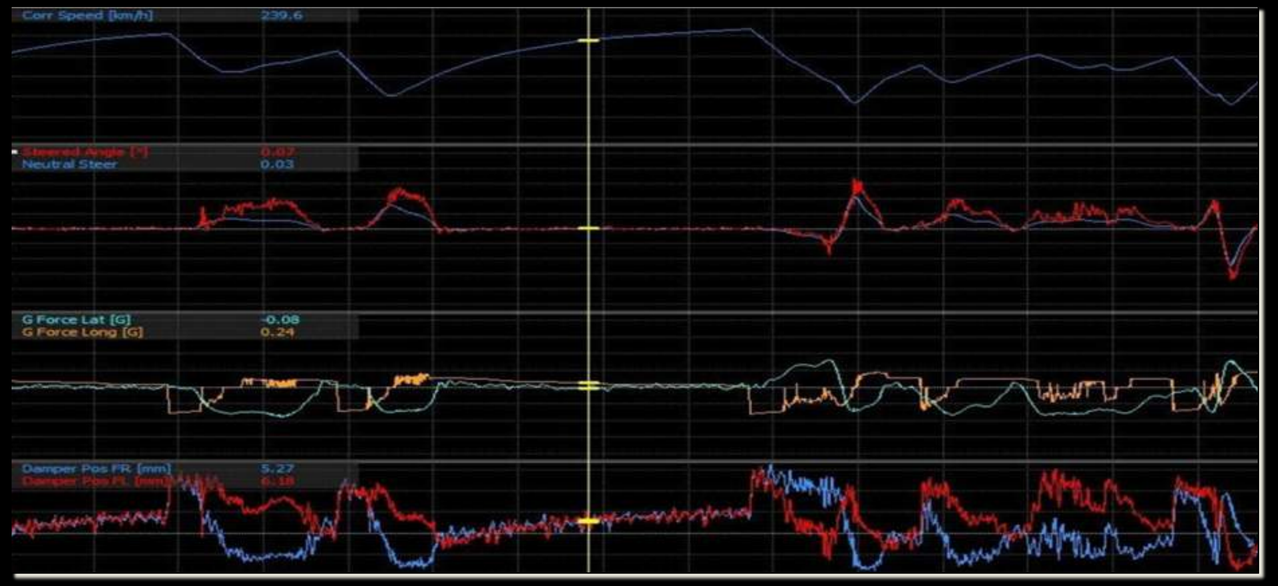
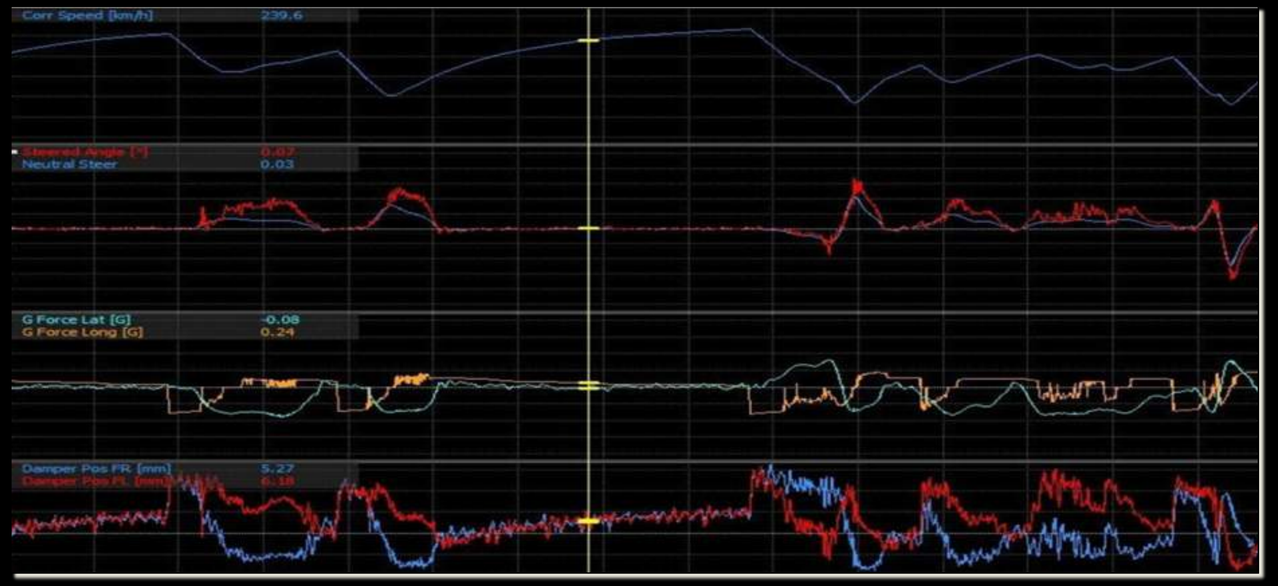

Corr Speed [km/h]
239.6
Steered Angle [°]
0.07
Neutral Steer
0.03
G Force Lat [G]
-0.08
G Force Long [G]
0.24
Damper Pos FR [mm]
5.27
Damper Pos FL [mm]
6.18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G Force Lat [G]
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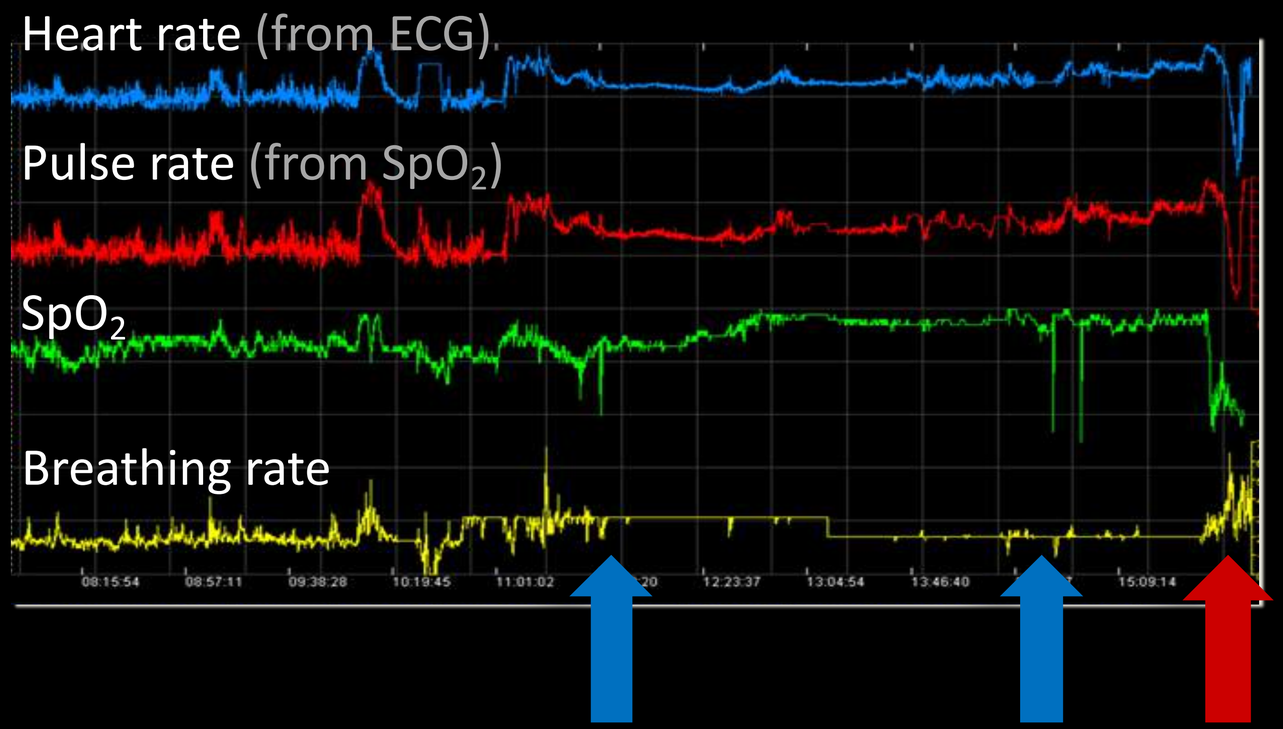
G Force Long [G]
0.24
Damper Pos FR [mm]
5.27


Heart rate (from ECG)
Pulse rate (from SpO2)
SpO2
Breathing rate
08:15:54
08:57:11
09:38:28
10:19:45
11:01:02
12:23:37
13:04:54
13:46:40
15:09:14
Cardiac arrest

McLaren
APPLIED TECHNOLOGIES
Caroline Hargrove
Duncan Bradley
Adam Hill

Ian Rhodes
CEO
Caroline
Hargrove
Duncan
Bradley
Adam
Hill

Peter van Manen

"80% of what happens in a hospital is completely predictable.

We need to free the intellectual capacity of the staff to sort out the vital 20% that is unpredictable"

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Real-time Adaptive & Predictive Indicator of Deterioration

RAPID

Dr Heather Duncan
Professor David Lowe
Dr Peter van Manen

Supported by
wellcome trust

Birmingham Children's Hospital
Registered Charity Number: 1074650

McLaren ELECTRONIC SYSTEMS

Aston University Birmingham

isansys

UNIVERSITY OF BIRMINGHAM

Proof of concept

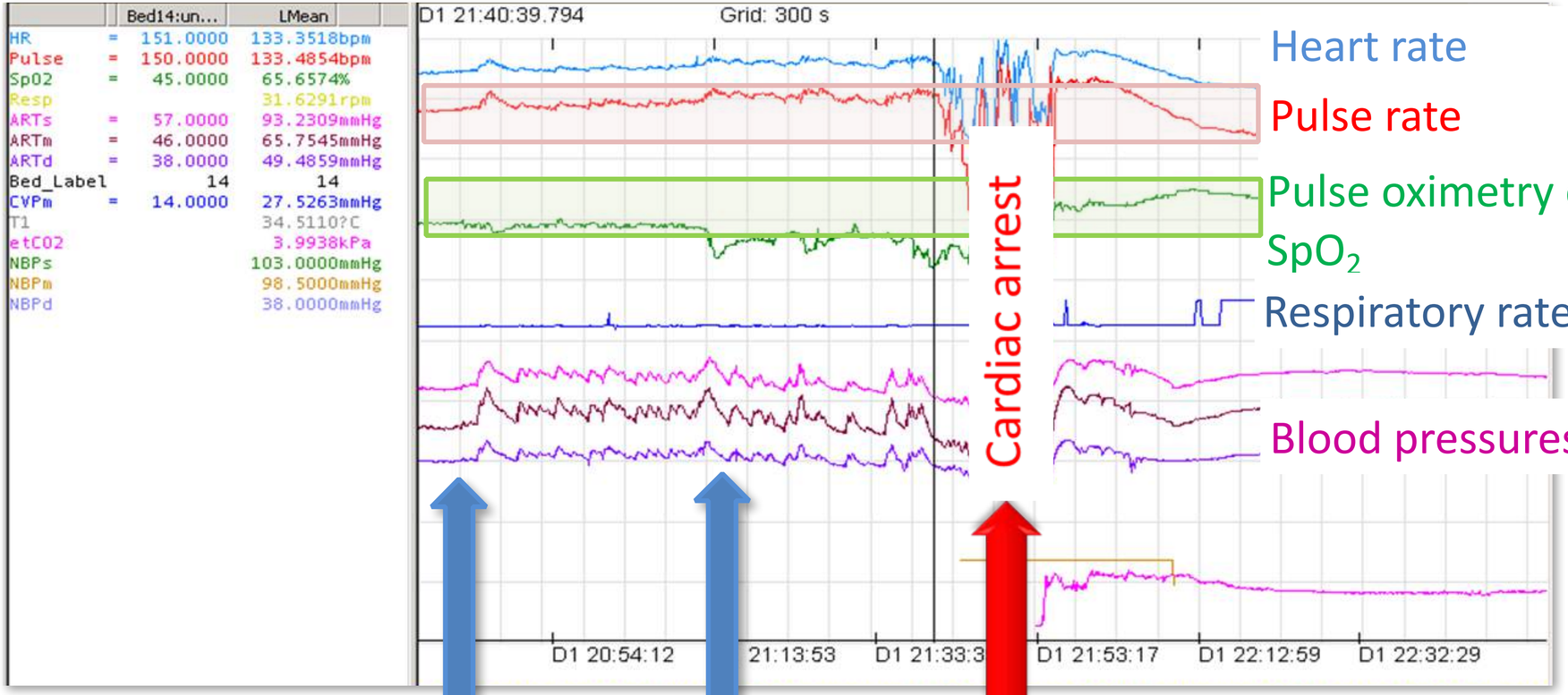
20 Intensive Care beds

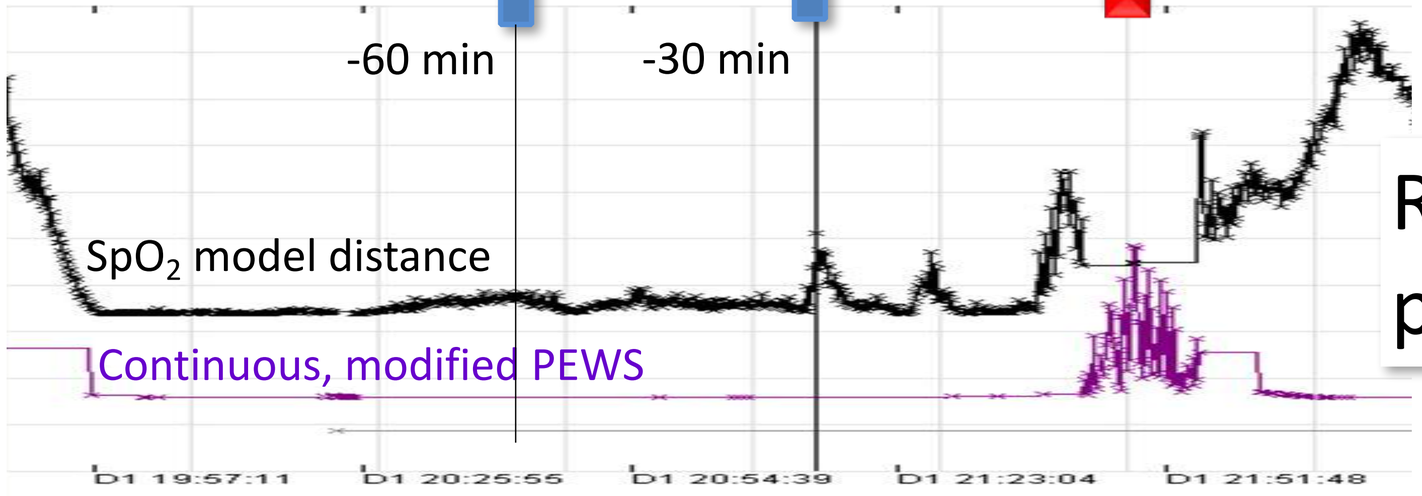
1 ambulance trolley

4 cardiac beds

Young Lives
Health Foundation funded
~3000 patients recruited
Some cardiac arrests predictable
Some unplanned extubation predictable
Trends needed in PICU
Smart alarms can work

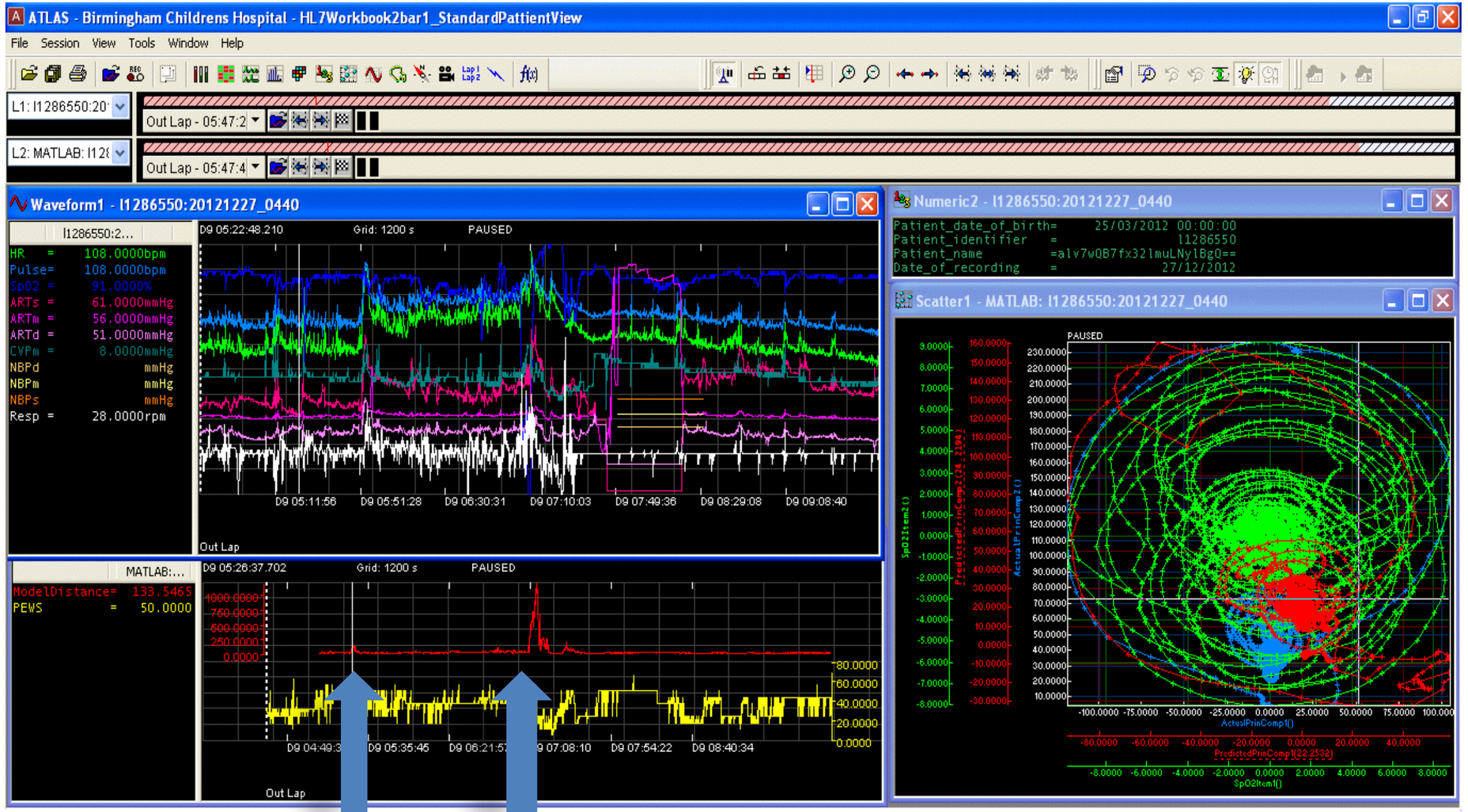
RAPID pilot
Wellcome HICF funded
41patients recruited
Wireless monitoring possible





Redefining predictable

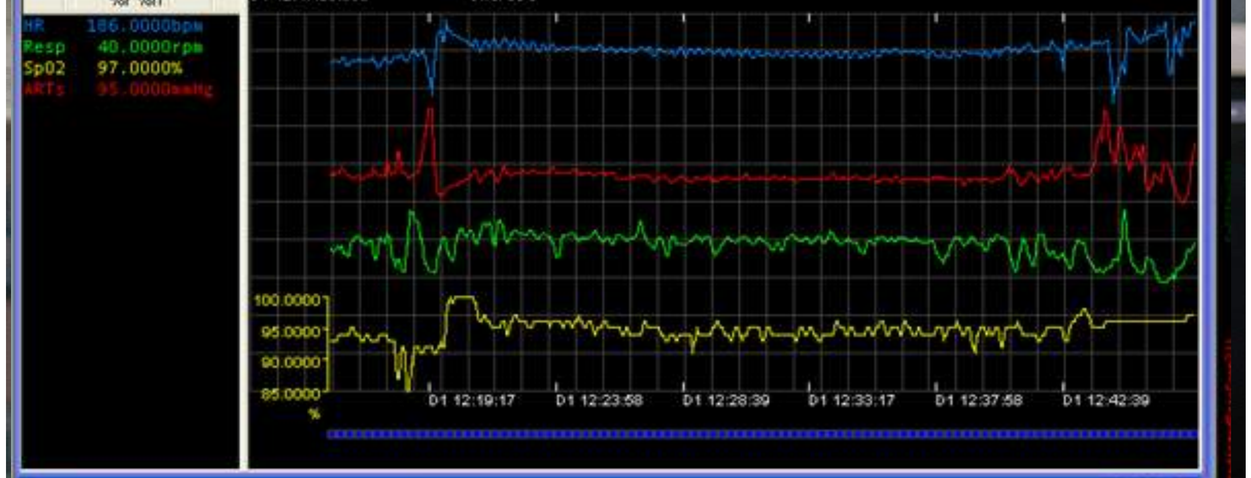
T21 child with pulmonary hypertension

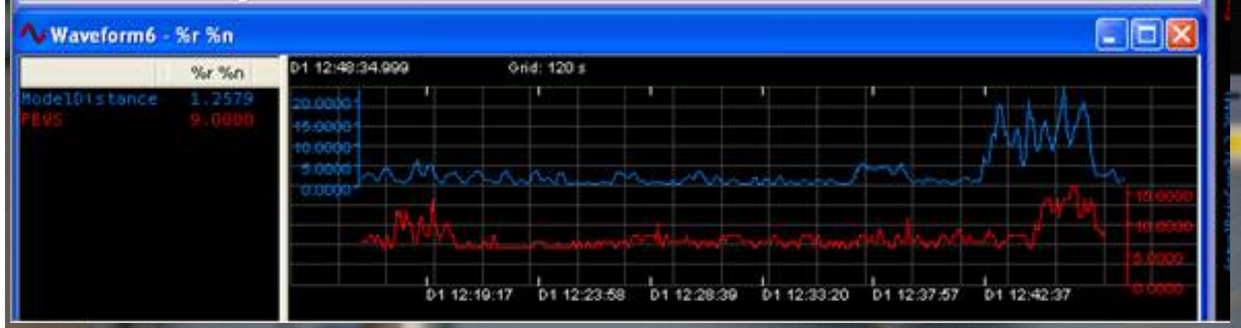


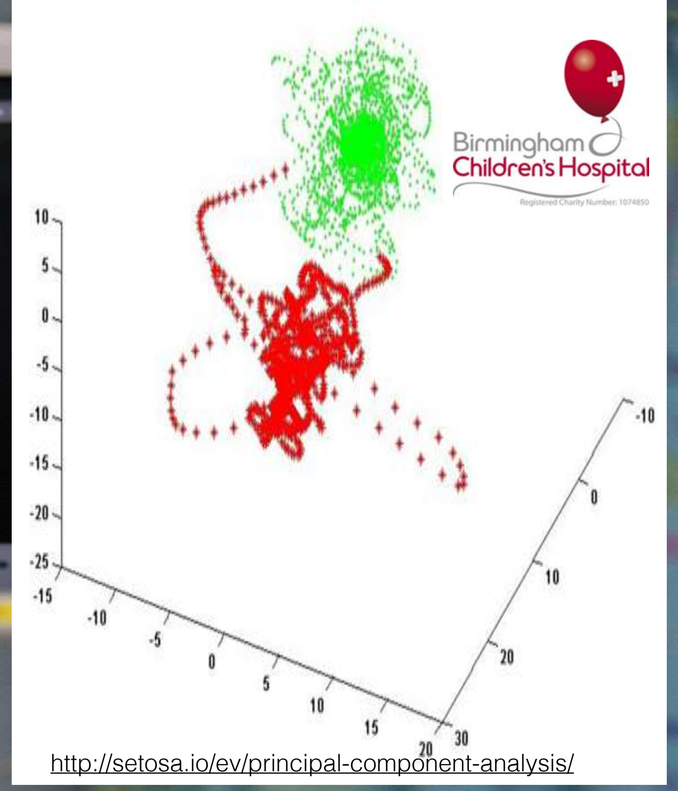
First warning at 5.26
Wakes up at 6.26

Unplanned extubation at 7.06

Not visible with bedside monitoring but could we predict this in future?







http://setosa.io/ev/principal-component-analysis/

Peter van Manen

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Peter van Manen

- modern children’s hospital even more complicated than F1

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- hospital teams change, often daily

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- modern children’s hospital even more complicated than F1
- hospital teams change, often daily
- to be able to innovate and make change, the **culture** must be right

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Peter van Manen

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self-criticism, willingness to learn, willingness to change

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Peter van Manen

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Heather Duncan

self-criticism, willingness to learn, willingness to change

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Boston, Toronto and GOSH

etiometry

HOME TECHNOLOGY ABOUT US CAREERS

T3

The Tracking, Trajectory, Trigger *(T3)* intensive care unit software solution allows researchers and quality improvement teams in the ICU to aggregate data from multiple sources, store it for analysis, and view the streaming data in real-time.
System features include:

www.etiometry.com

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HOME TECHNOLOGY ABOUT US CAREERS

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System features include:

www.etiometry.com

Sensors **Data** **Store** **Analyse** **Add Insight** **Guide Strategy**

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Rapid Prototyping

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Rapid Prototyping

- 25,000 components

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Rapid Prototyping

- 25,000 components
- every two weeks, 5,000 new components designed and built

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Rapid Prototyping

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- 5-10% of the car is different for each race

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CAD and 3D Printing

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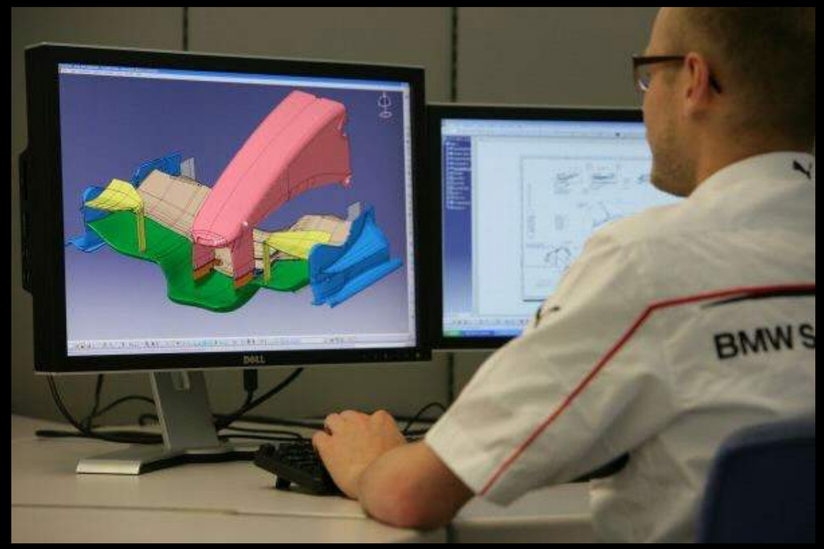
CAD and 3D Printing



ducting, aerodynamic parts, etc…even at the track

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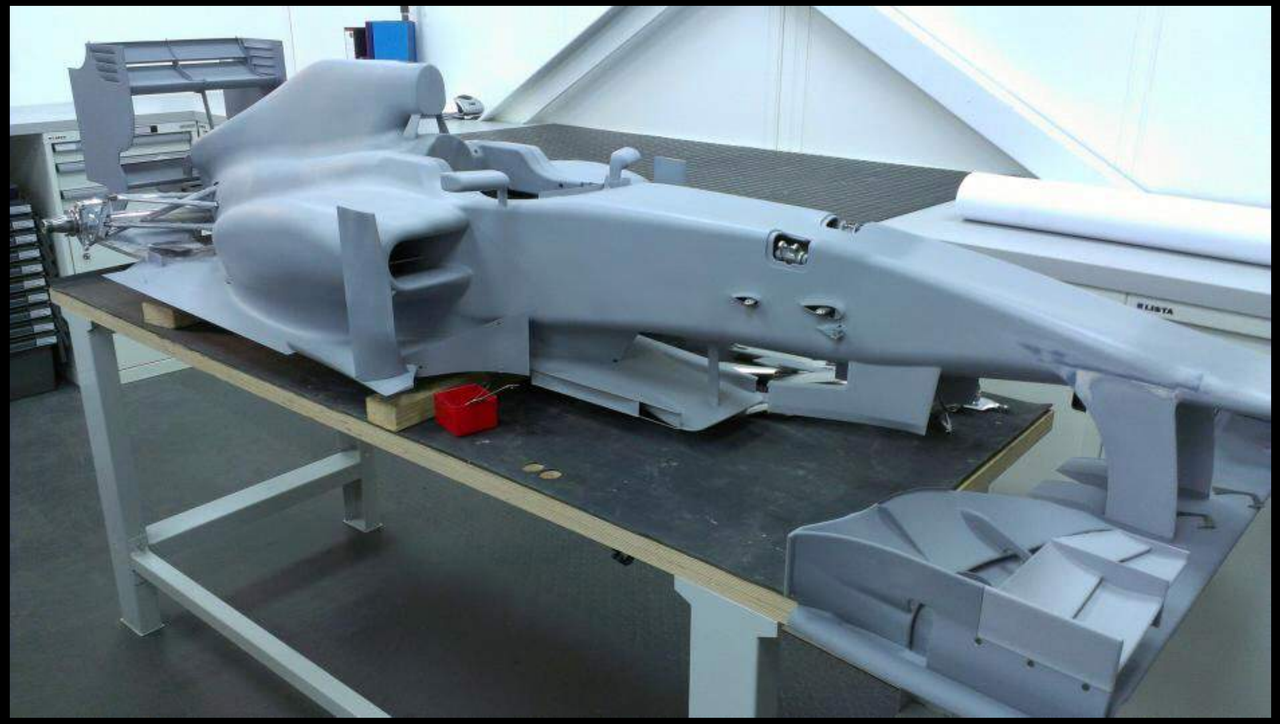

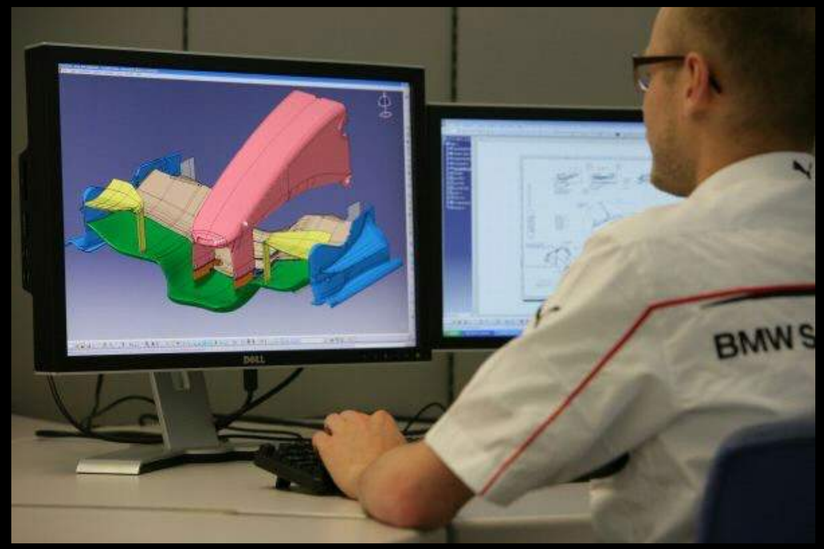

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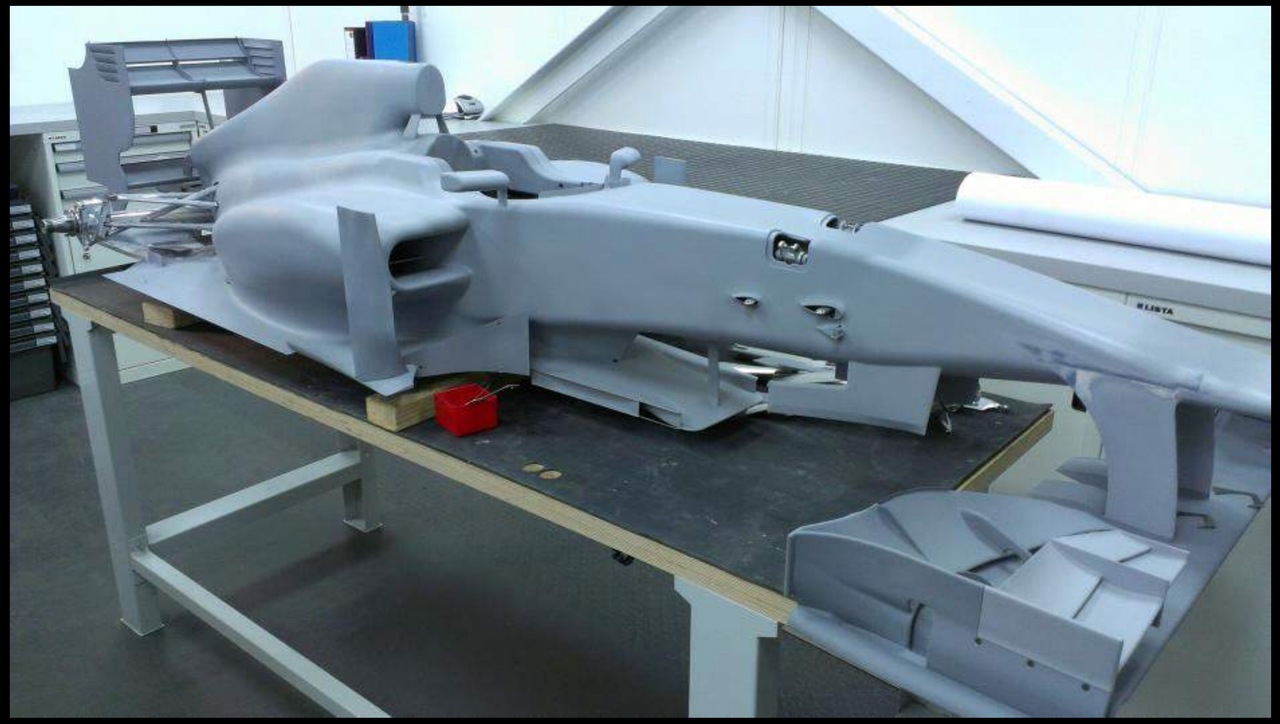
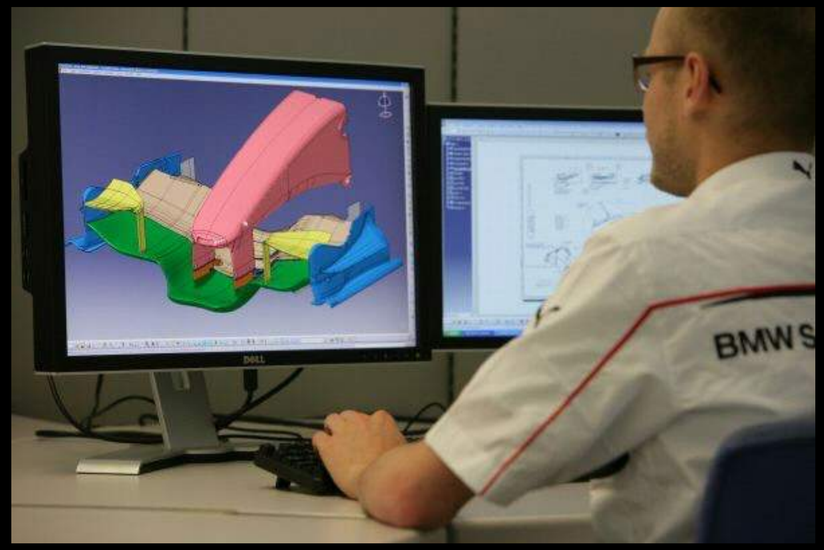


3D Printed Trophy



ducting, aerodynamic parts, etc…even at the track

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1st 3D printed racing car

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1st 3D printed racing car

3D printed army/navy retractor

Printed in 90 mins,
and 10% of cost of steel

J Surg Res. 2014 June 15; 189(2): 193–197.

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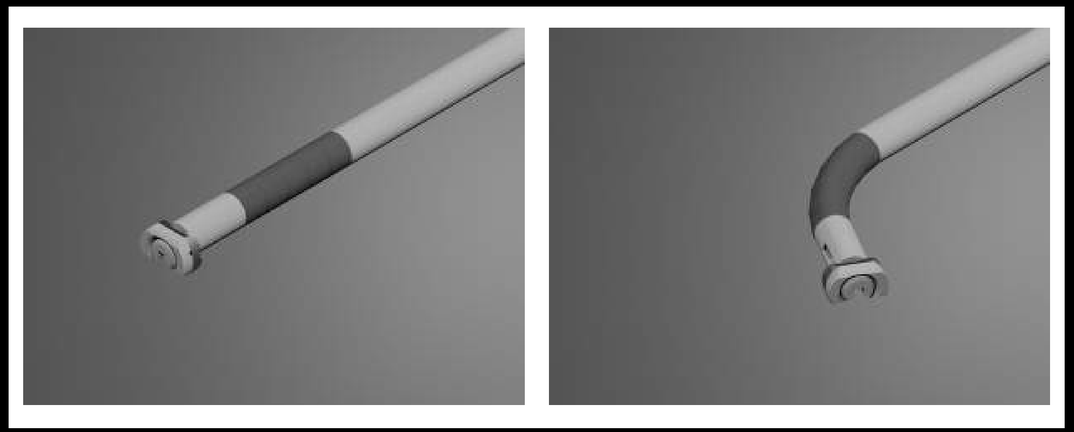

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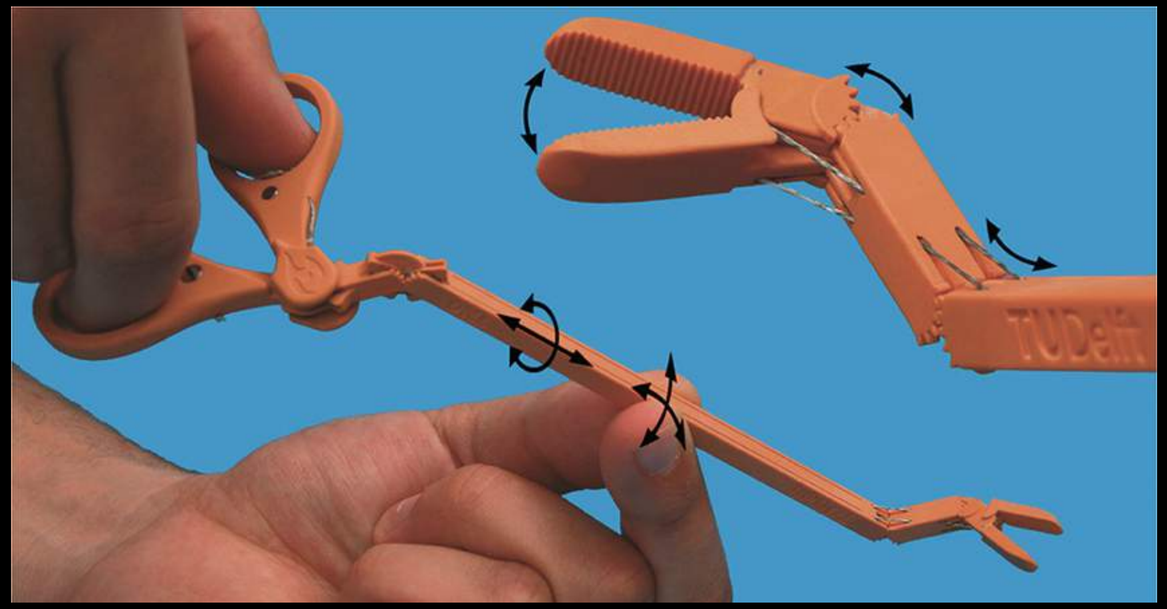
artisanmodelmakers.co.uk



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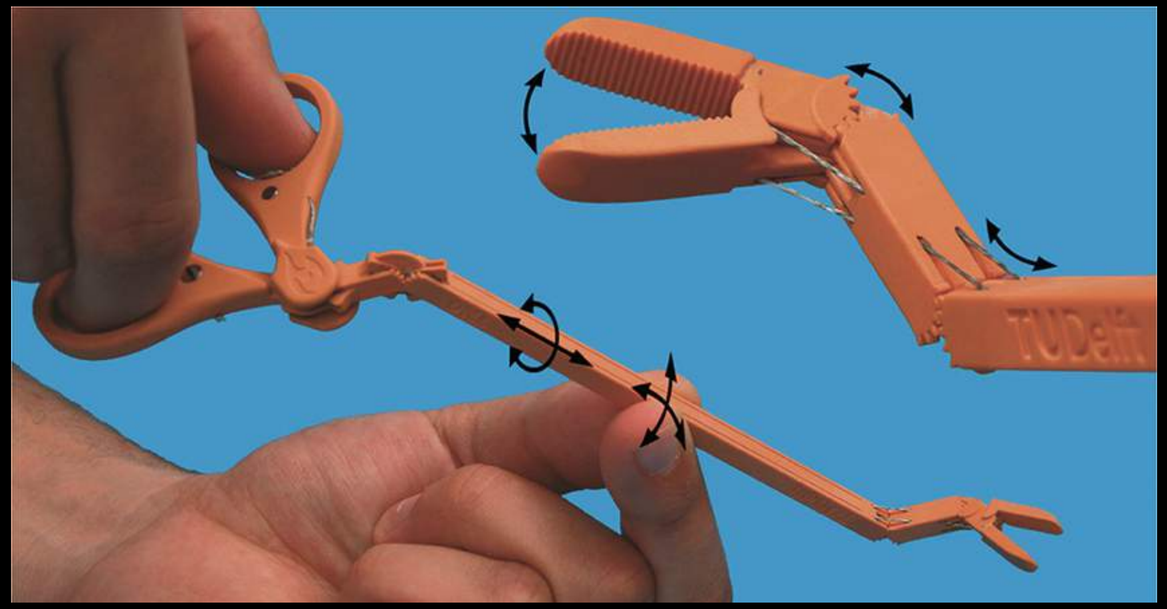

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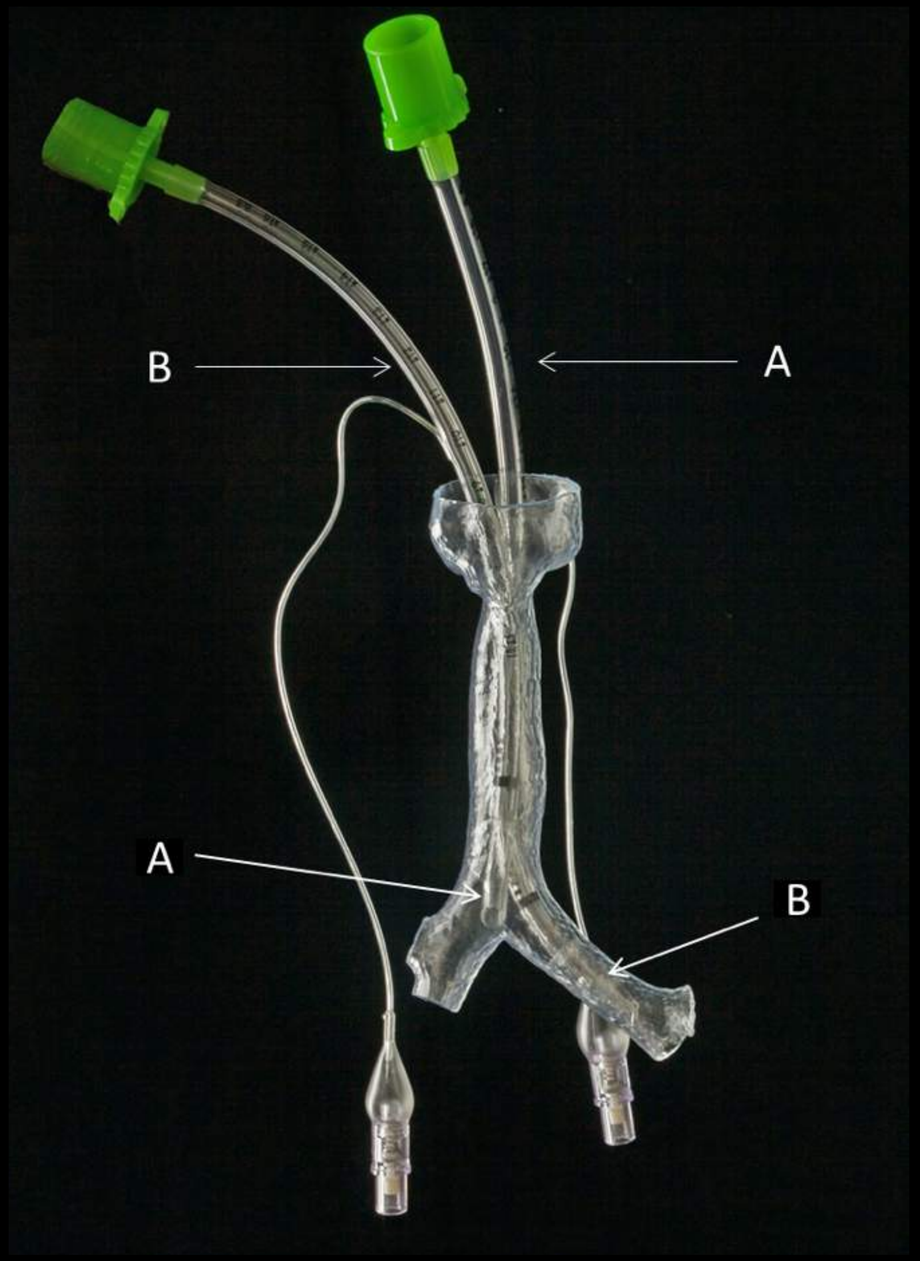

Images Courtesy of Dr Colin Wallis GOSH

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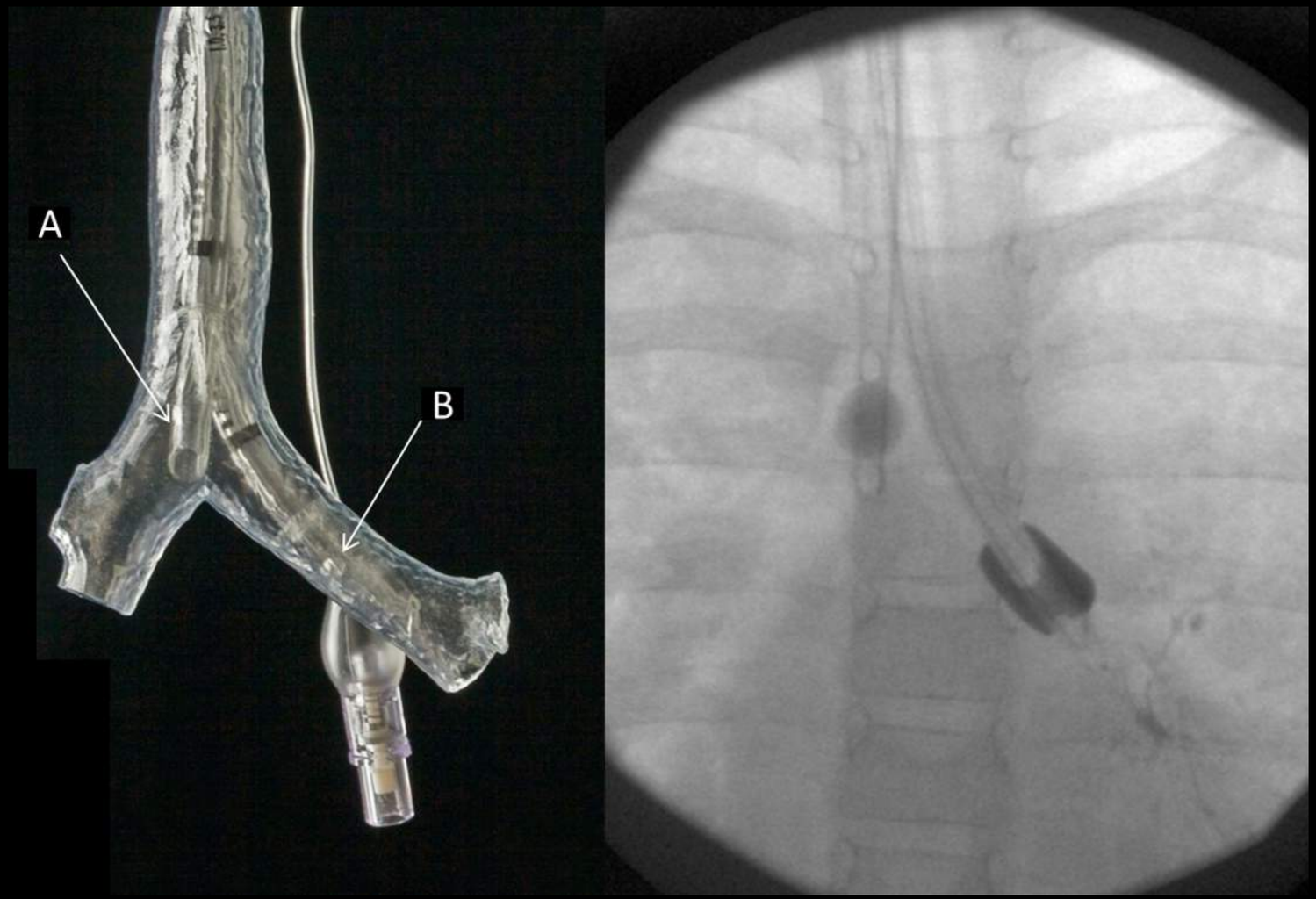

Images Courtesy of Dr Colin Wallis GOSH

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personalised prosthetics

rapid size-matched (3D print rapid prototyping) nanotechnology designed **POSS-PCU** external stent;

human cells will adhere to it

courtesy of Alex Sefailian and Clare Crowley, UCL, London

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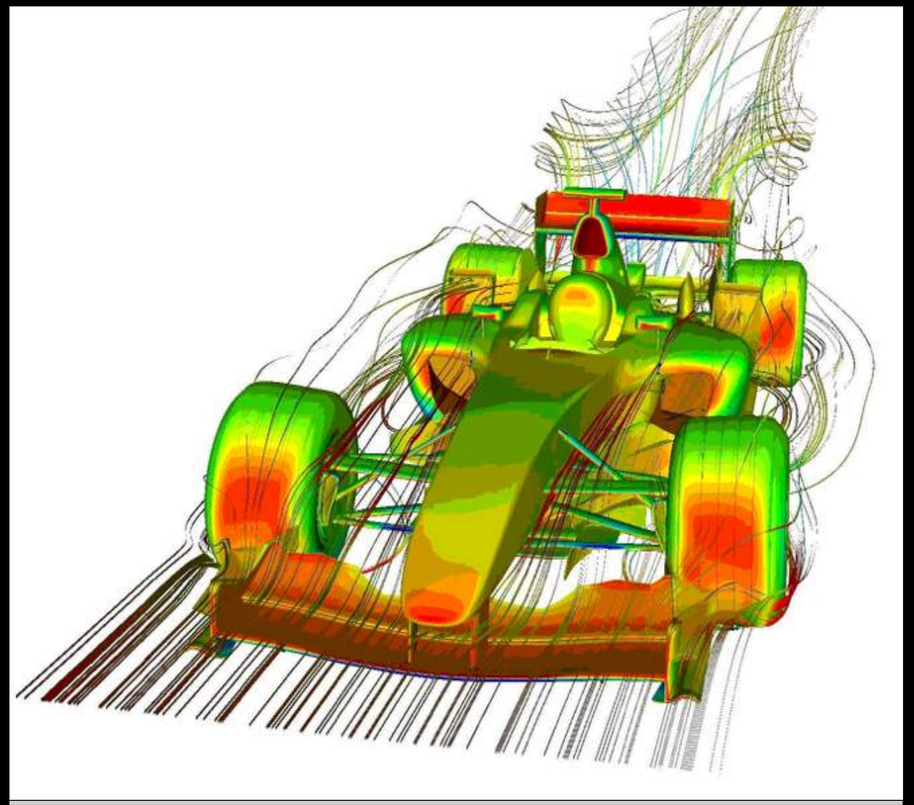

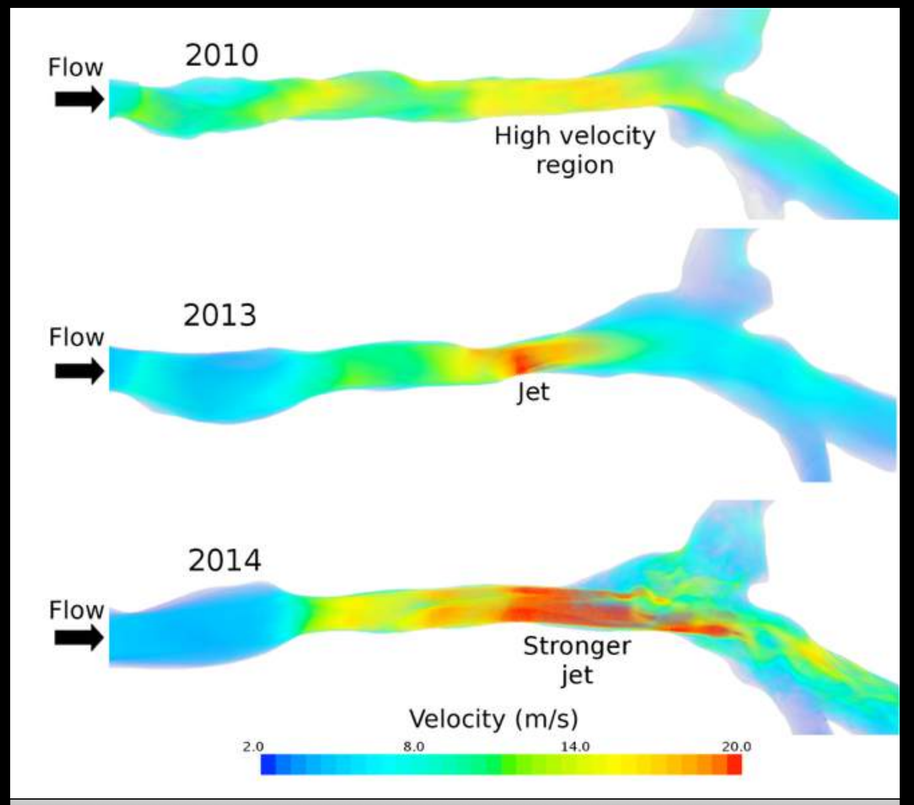

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Frank & Clare Williams
Williams F1 Racing

WILLIAMS MARTINI RACING

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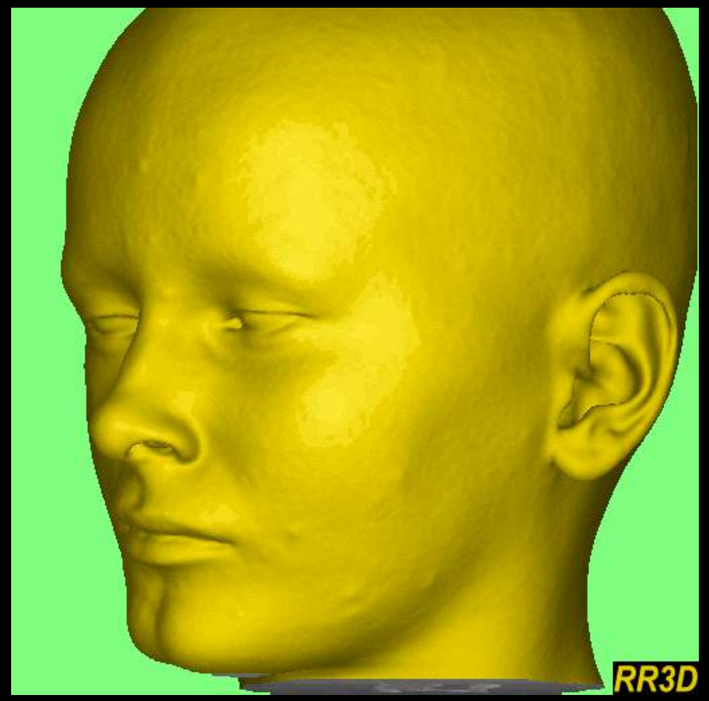

images courtesy of
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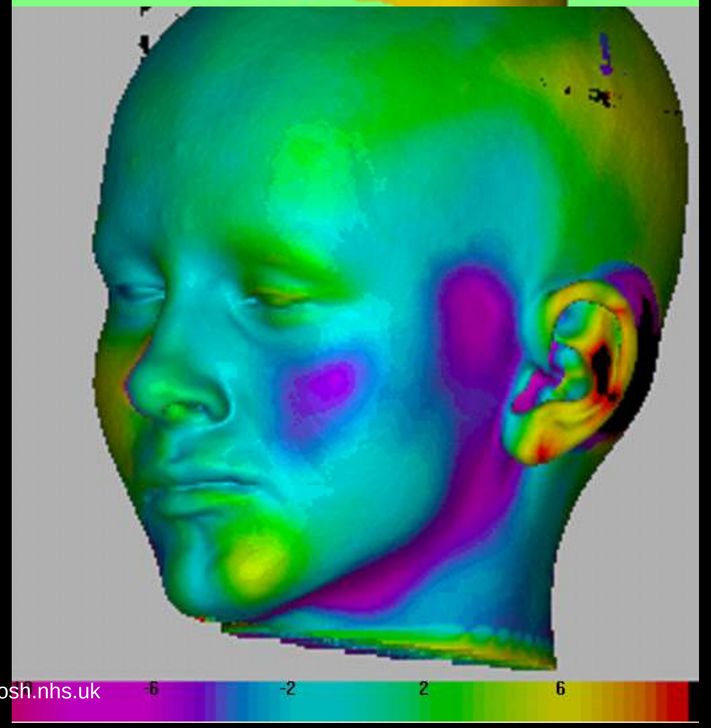
Great Ormond Street Hospital



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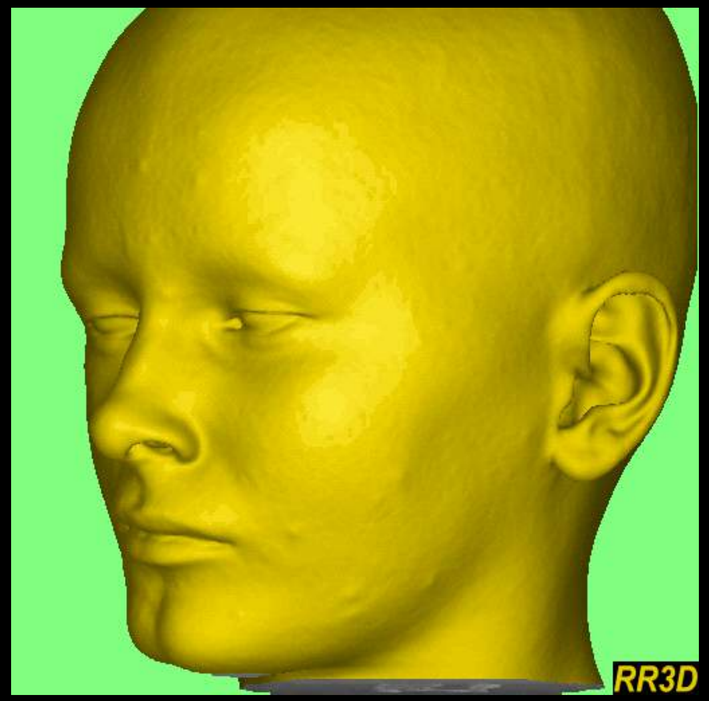

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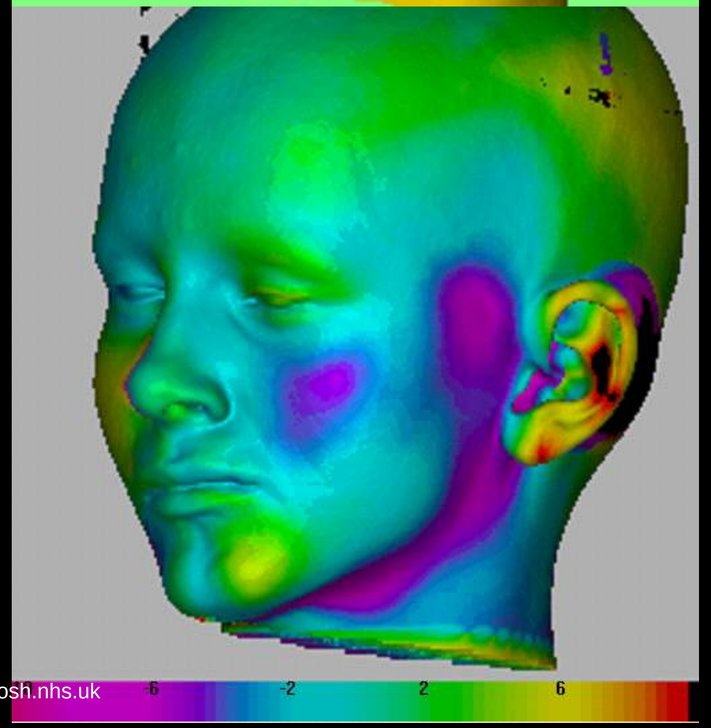

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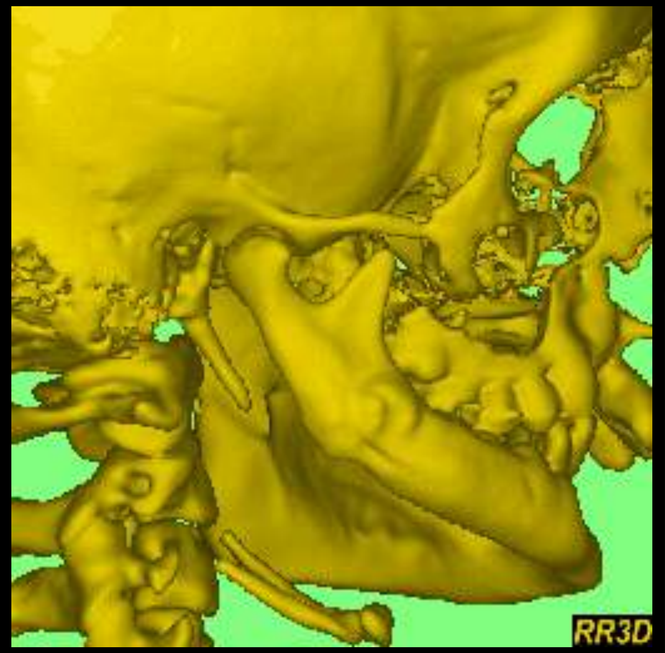
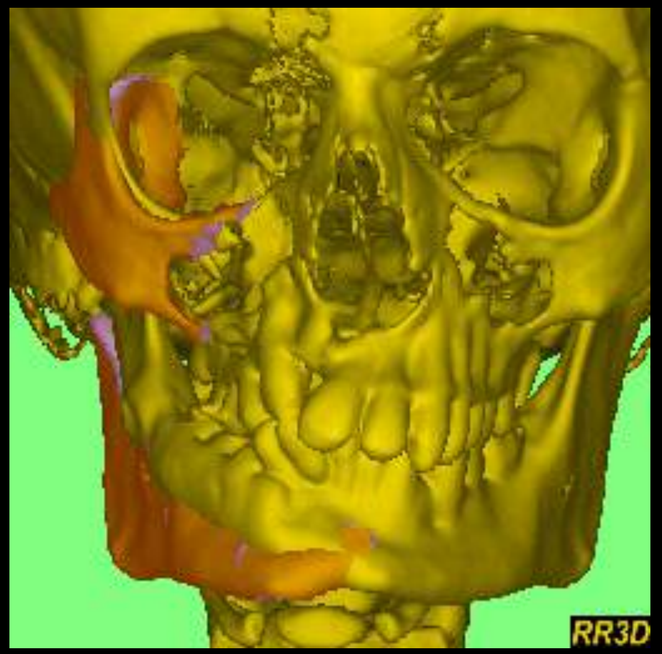
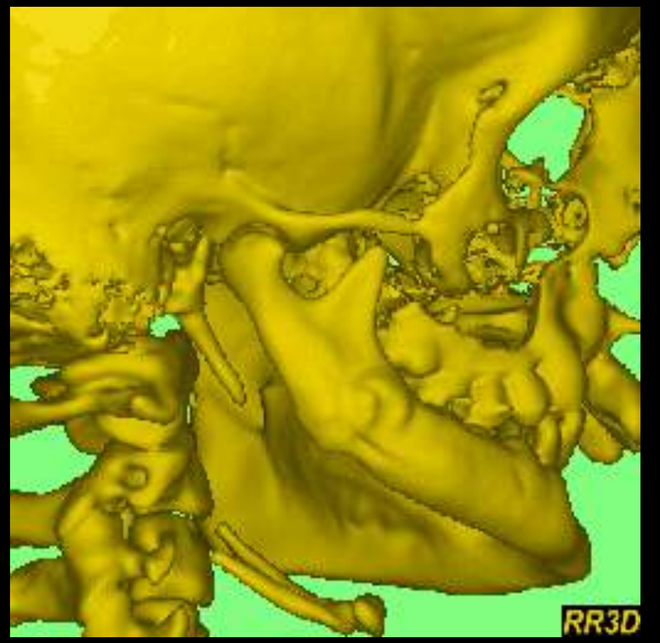
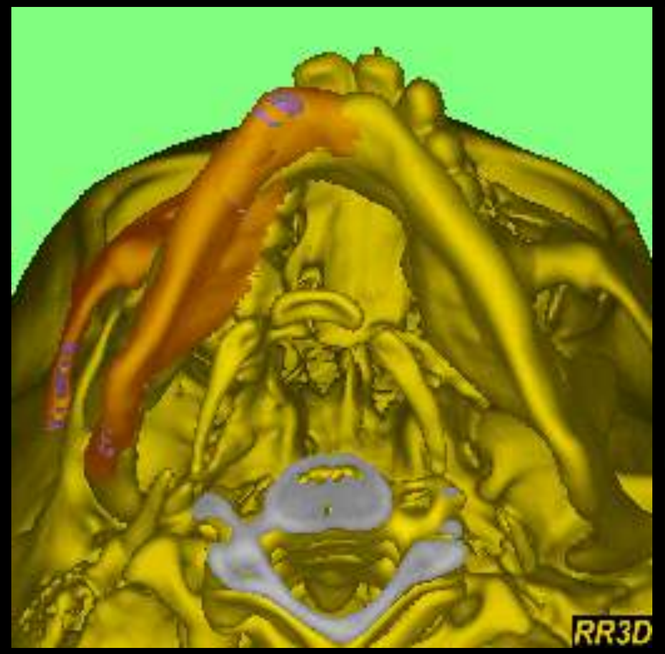
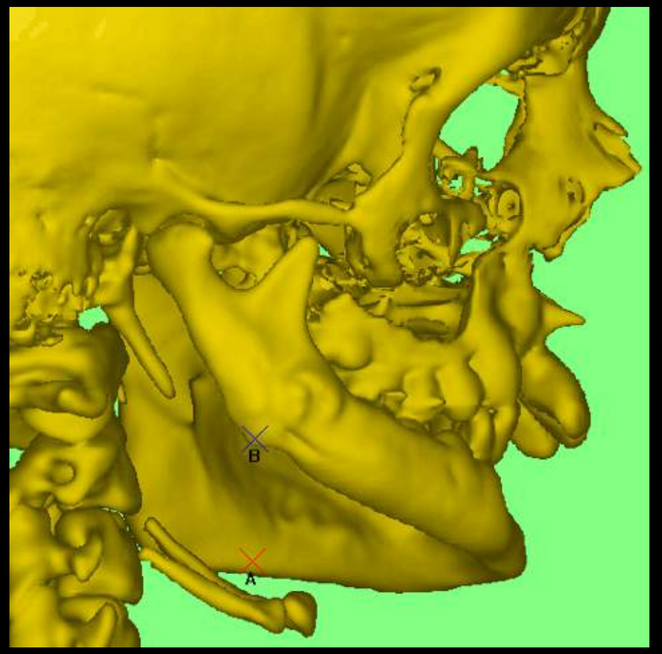
preparing personalised components

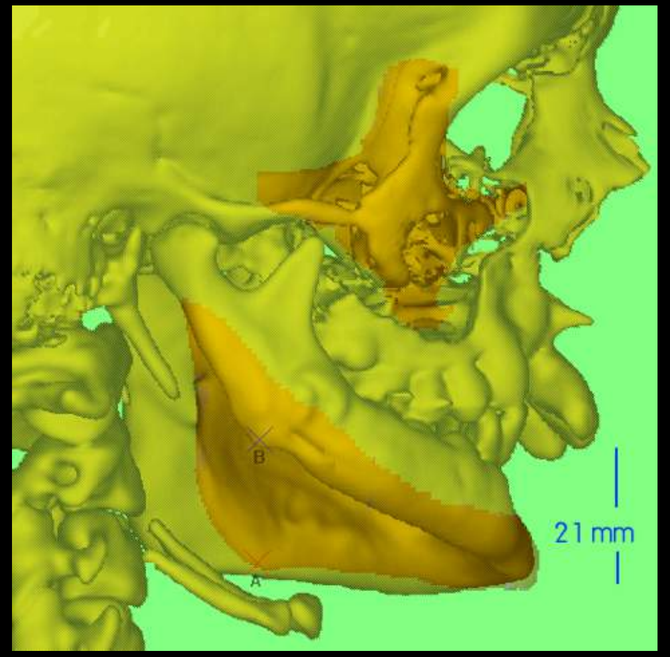












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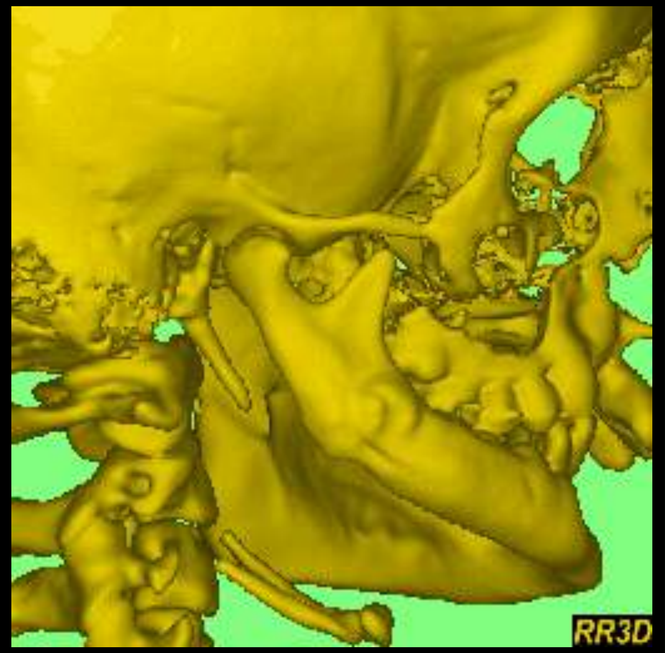

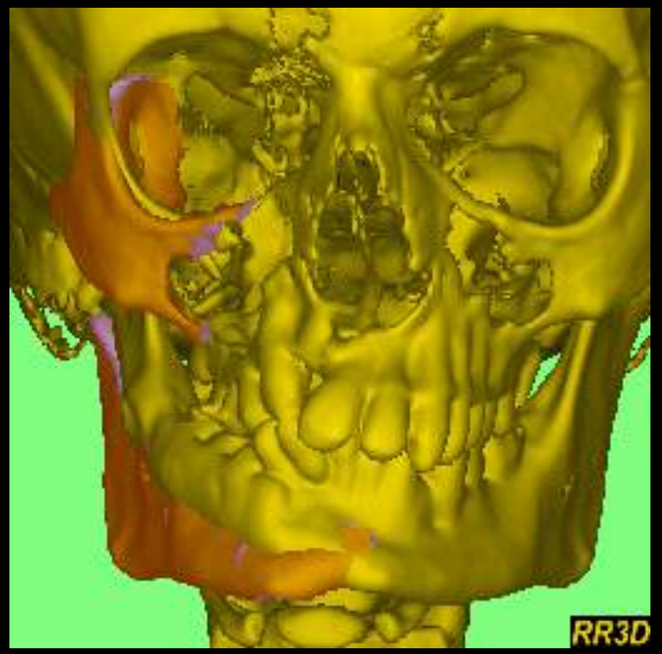

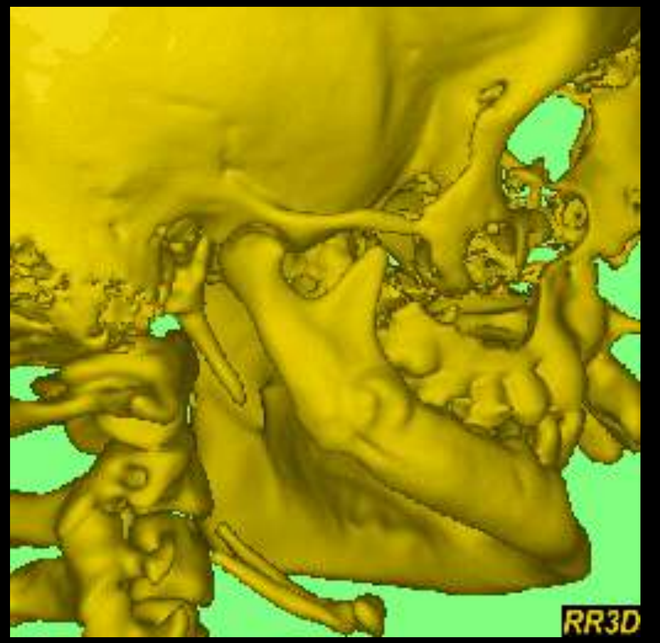

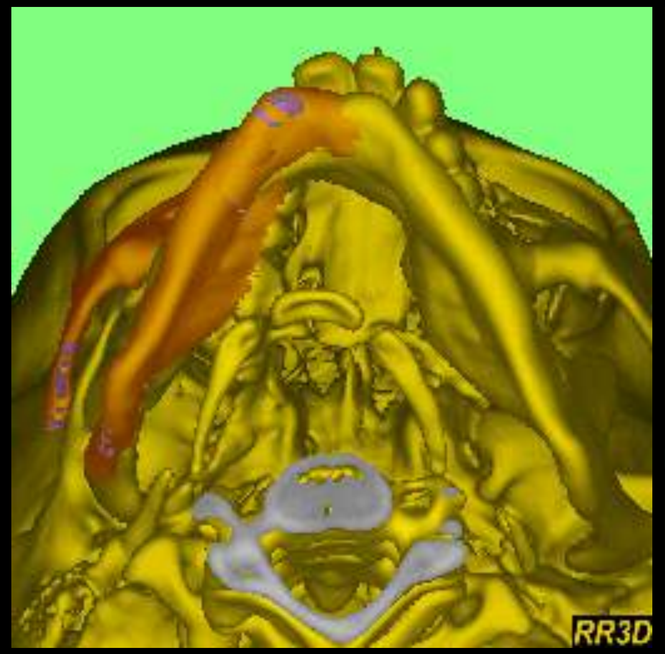

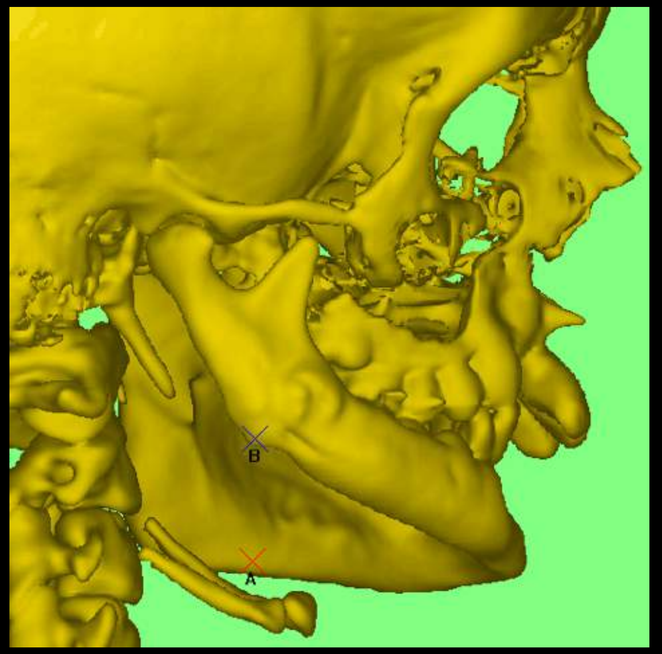

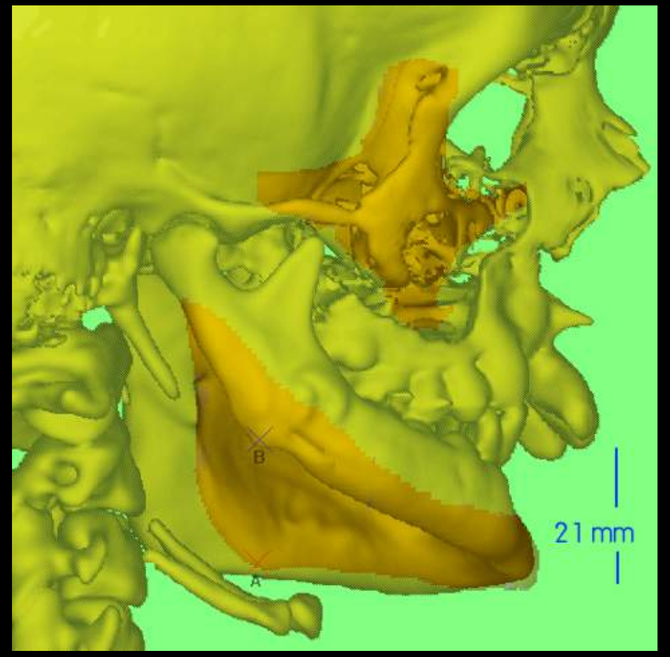

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According to the FDA, a vast majority of investigational products never make it through clinical approval and market adoption.

— Jon Johnson

a waste:
of time, energy, talent and money

http://www.cam.ac.uk/research/news/commercialising-medical-device-innovation

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some products do get to market

TREKINETIC FACTORY
LONDON
TREKINETIC
DESERT

TREKINETIC FACTORY
LONDON
TREKINETIC
DESERT

SILVERSTONE CIRCUIT

MEDICAL CENTER

SILVERSTONE CIRCUIT

MEDICAL CENTER

Logistics

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Logistics

- 100,000 miles per season
- 100 hotel rooms per race
- 100 tonnes of stuff, spares, tools
- telecommunications
- tyres, fuel, oil, coolant, food
- drivers
- the cars

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- 100 hotel rooms per race
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- the cars

“Don't forget anything at home”

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Logistics

- **100,000 miles per season**
- **100 hotel rooms per race**
- **100 tonnes of stuff, spares, tools**
- **telecommunications**
- **tyres, fuel, oil, coolant, food**
- **drivers**
- **the cars**

the race always starts on time

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If they can do it, why can’t we?

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the pursuit of excellence

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nat. average

my hospital

best in class

100

95

90

85

80

75

70

Y1

Y2

Y3

Y4

Y5

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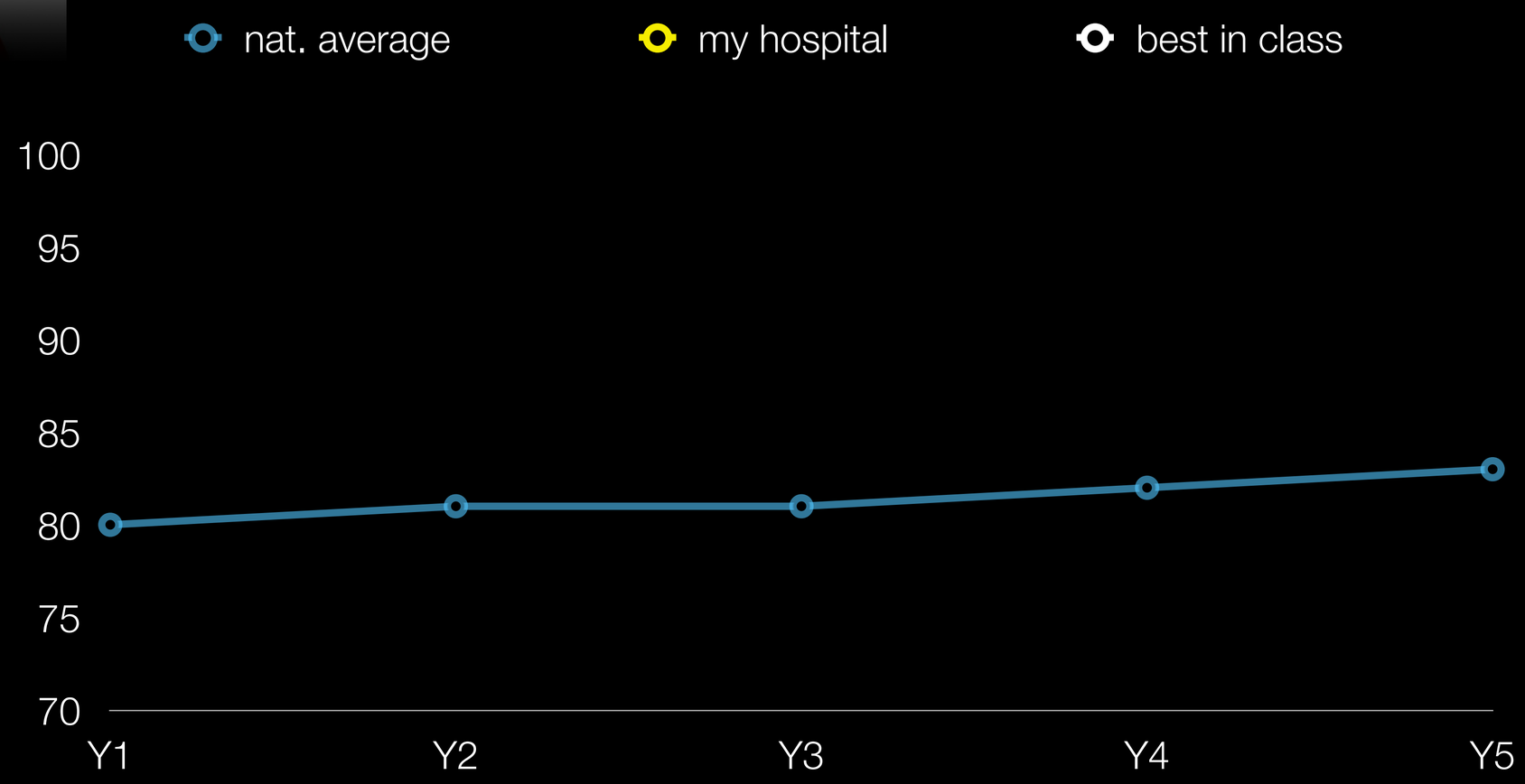

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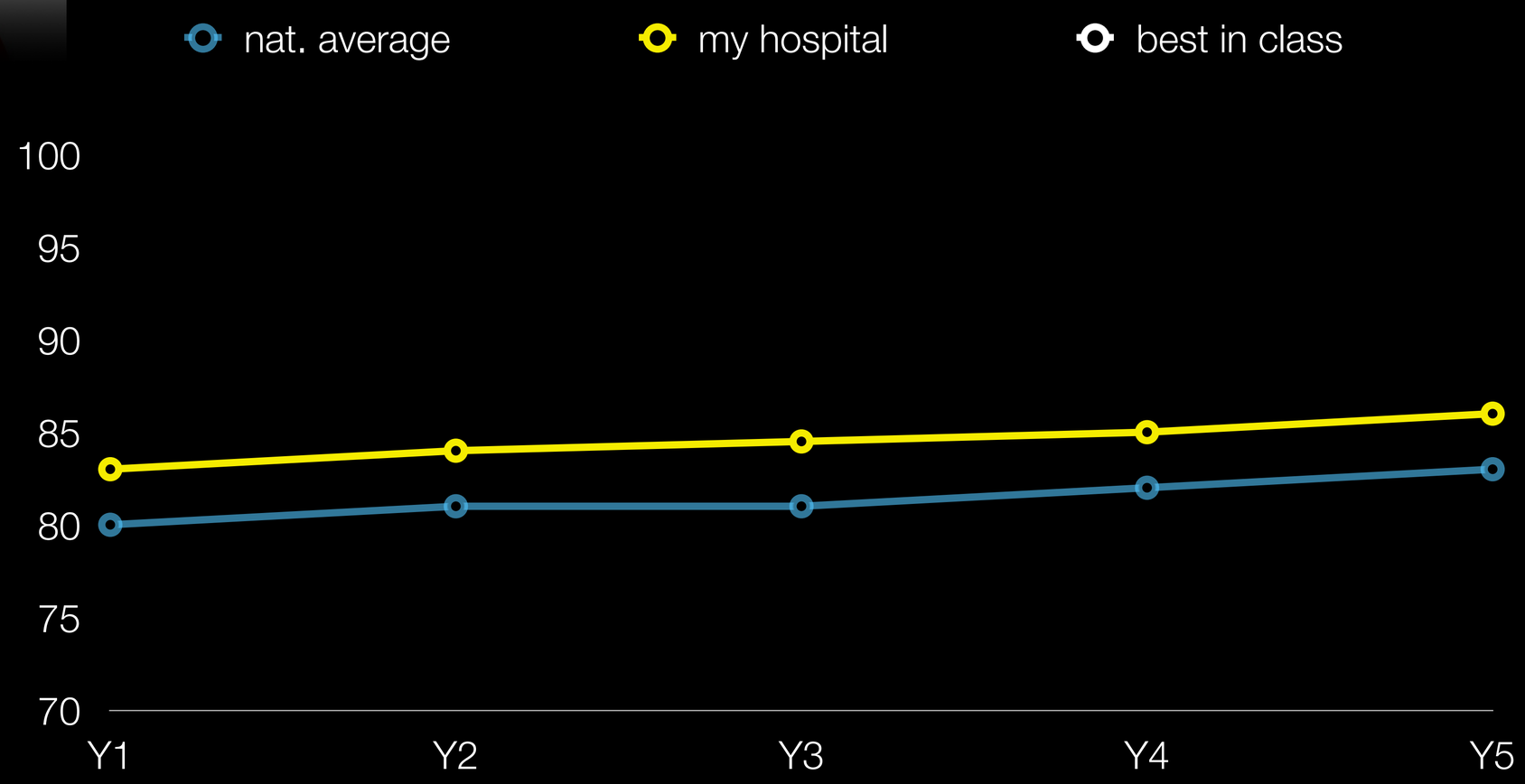

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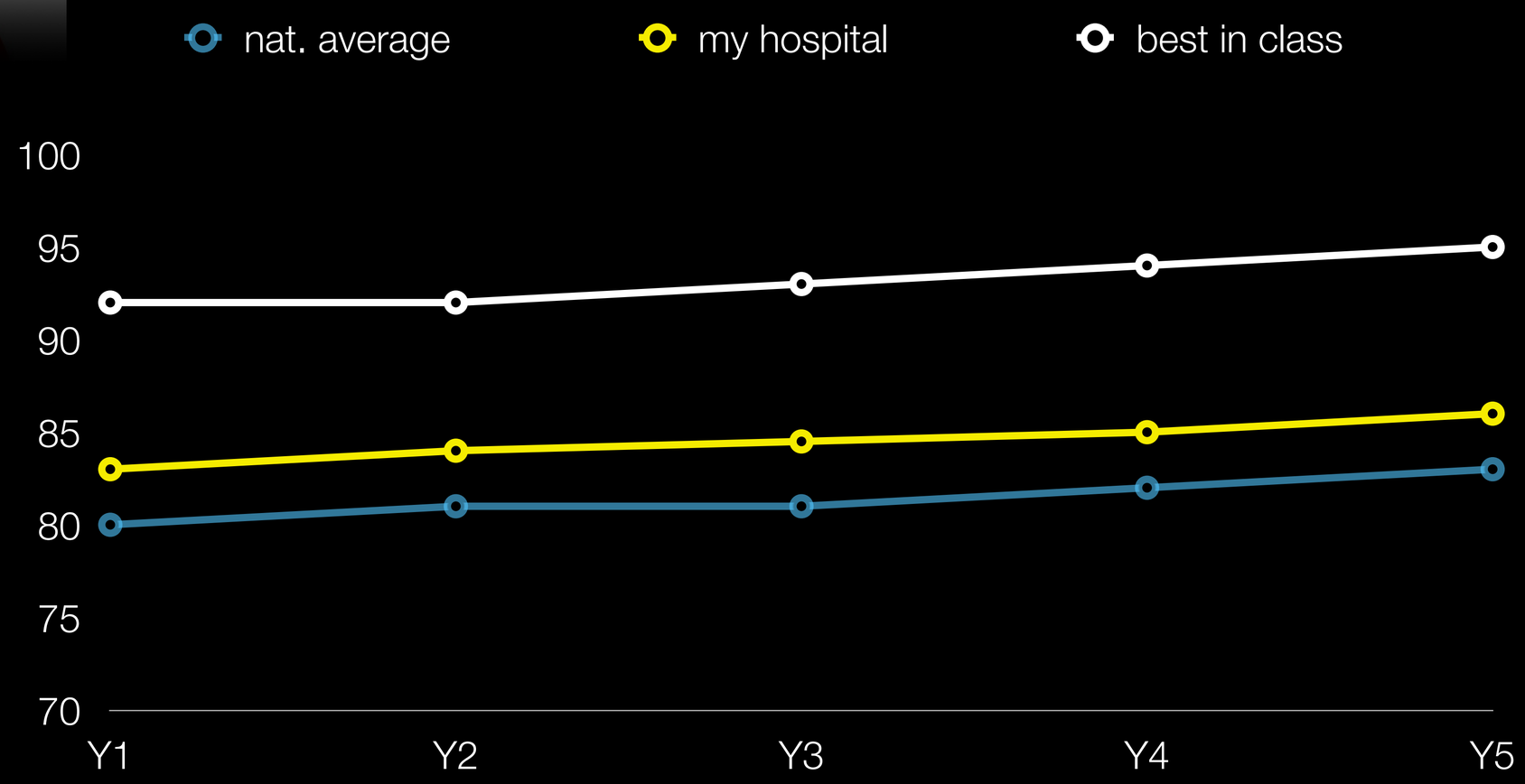

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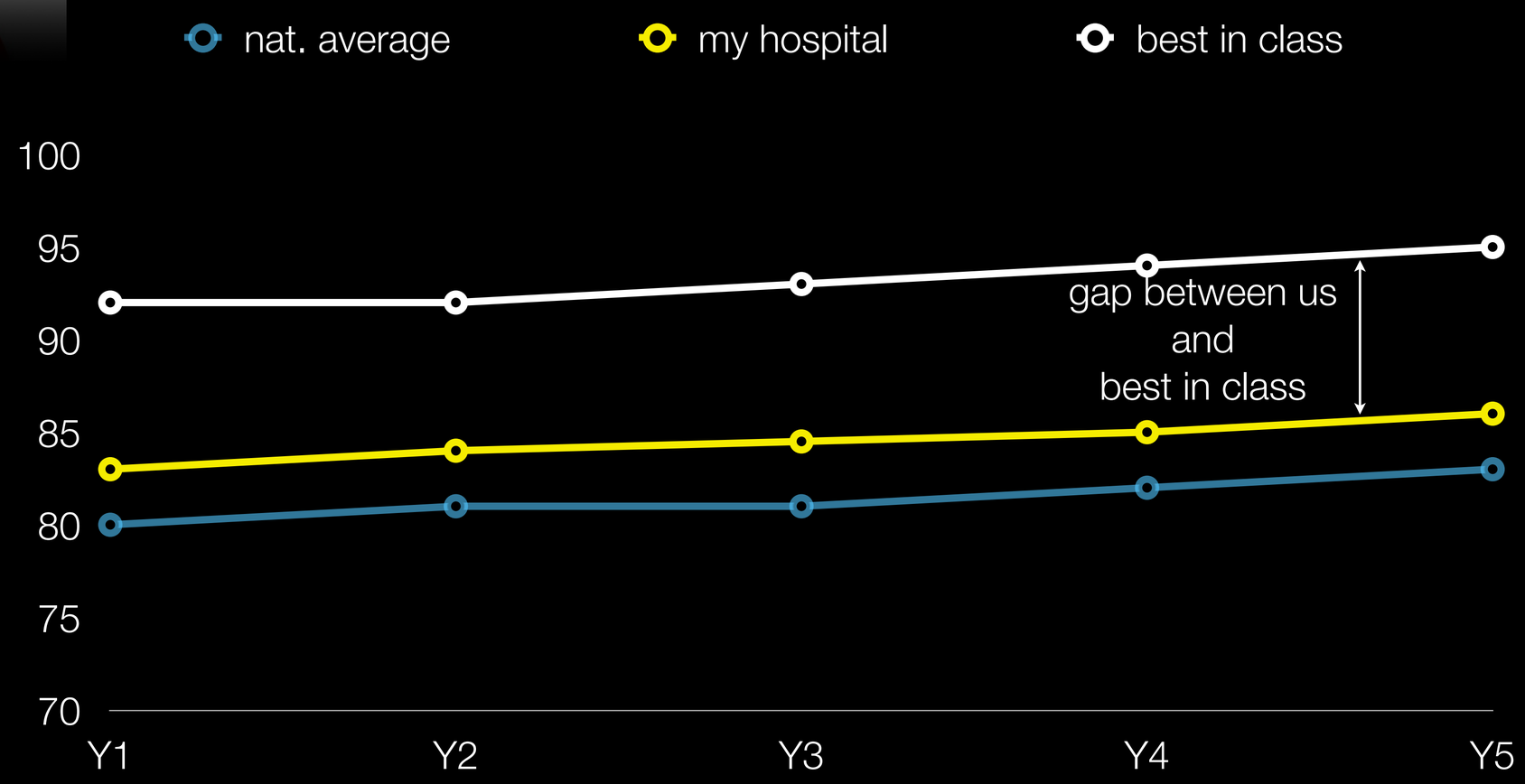

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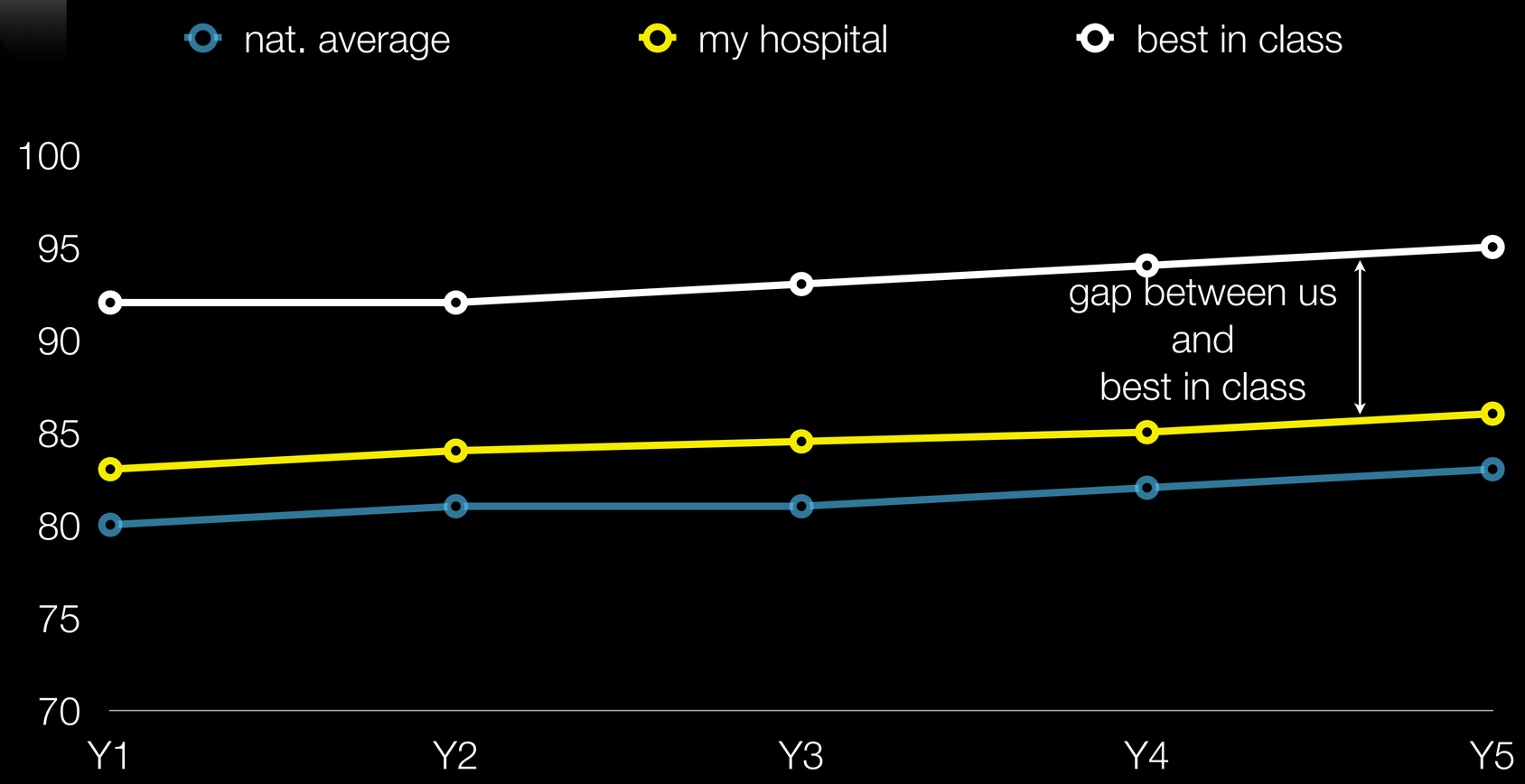
better than average isn't good enough



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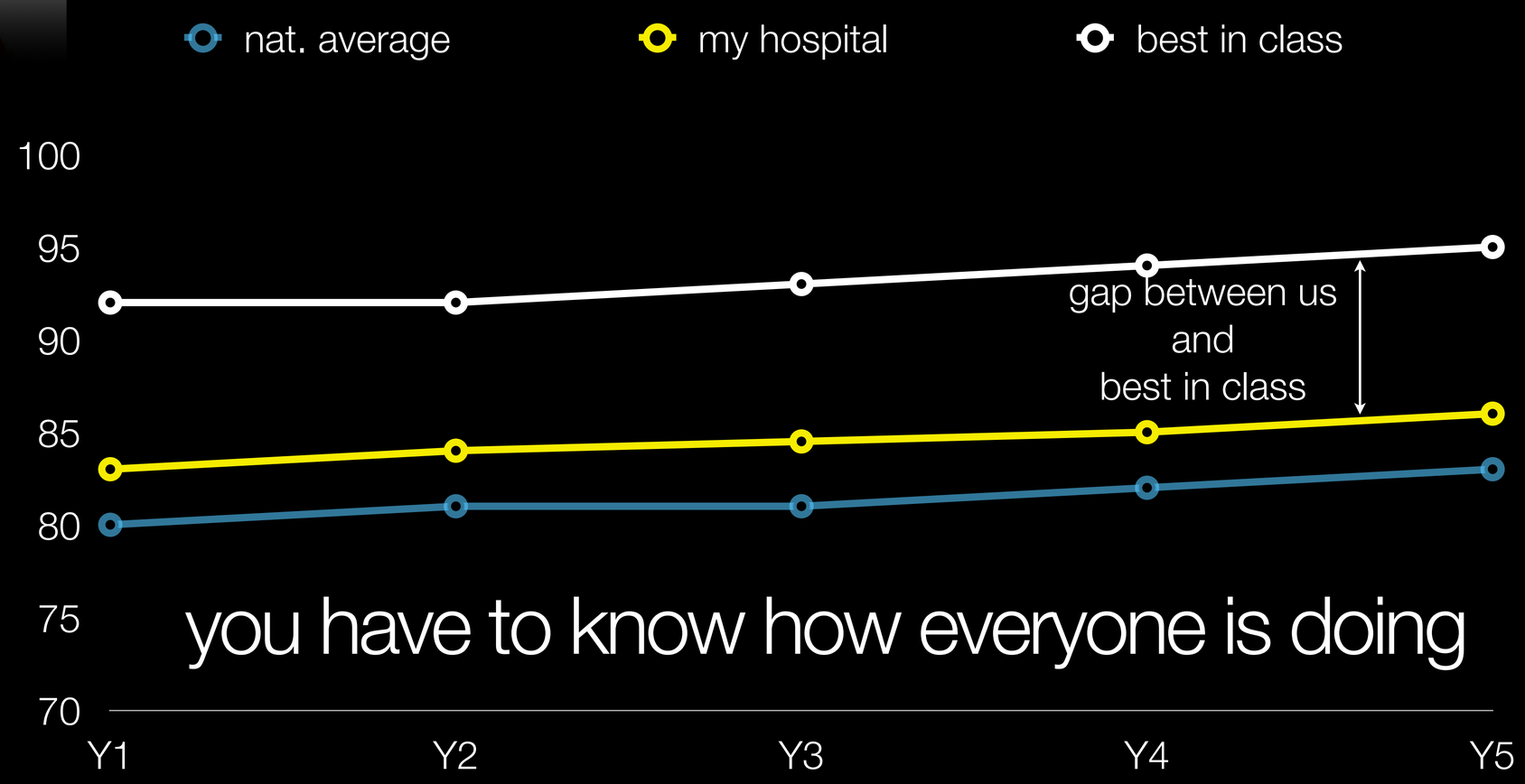
better than average isn't good enough



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marginal gains

Ross Brawn

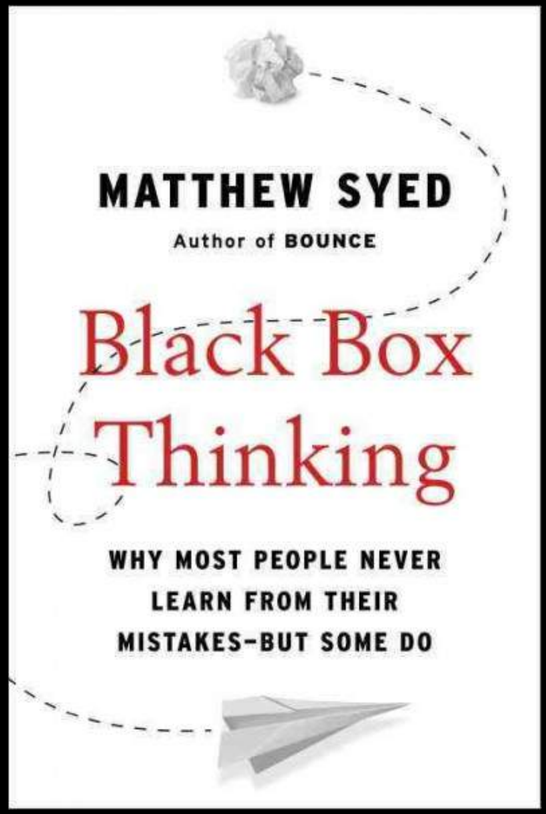
@ProfMJElliott

martin.elliott@gosh.nhs.uk

marginal gains

Ross Brawn

Dave Brailsford



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Talent wins races.
Team work & intelligence wins championships.

STRAKKA RACING

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The Finish

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Allan Goldman
Angus McEwan
Ken Catchpole
Jane Carthey
Marc de Leval
GOSH Children's Charity

Ferrari
Ross Brawn
Shell Petroleum
Clare & Frank Williams
McLaren Applied Electronics
Caroline Hargreaves
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Ian Rhodes
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