FORMTECH COMPOSITES

Composite Material Substitution in Formula 1

Implications for Industry

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Managing Director

Introduction

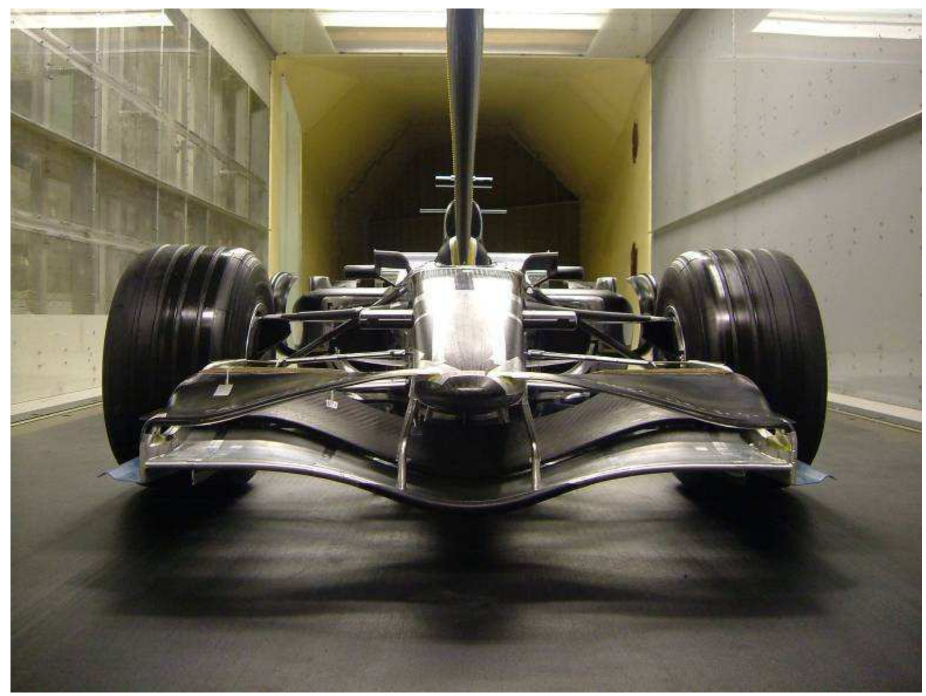
- Motorsports uses a large amount of composite material
- Industries such as Aerospace have ambitious targets
- Automotive targets are based around carbon reduction
- Safety is a key driver of composite substitution in F1 – monocoque is an example of this

How is Motorsports Relevant to Us?

- Question most often asked
- What are the key aspects of F1?
- How does it compare?
- How does F1 deal with innovation, risk and development

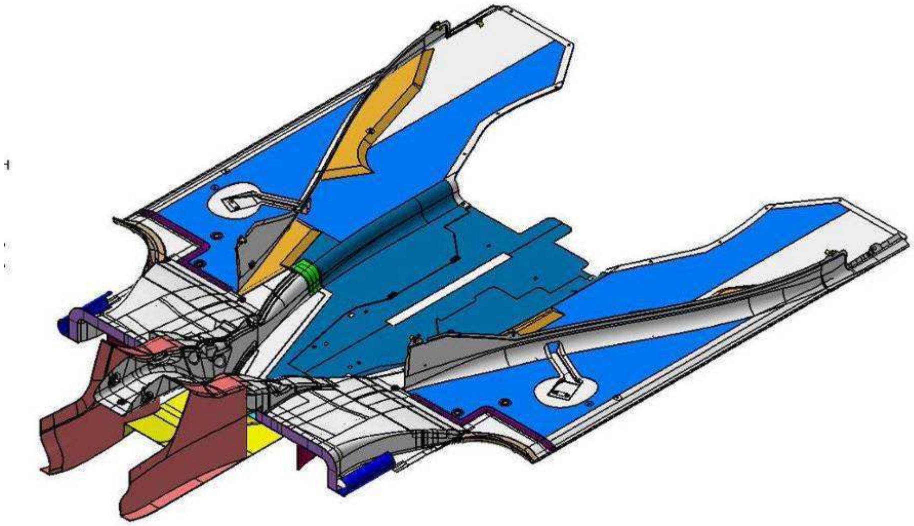
F1 – Basic Technical Facts

- 2,500 kg downforce
- 350 km/h top speed
- 5g deceleration
- 750 BHP @ 18,000 RPM
- 425kg without engine and driver
- Typical 80-900° C operating temperatures
- + 70% carbon parts – structural and cosmetic



Typical Manufacturing Schedule

- Design – 4 weeks
- Moulds – 2 weeks
- First off parts – 1 week
- Testing – 1 week
- TOTAL = 8 weeks



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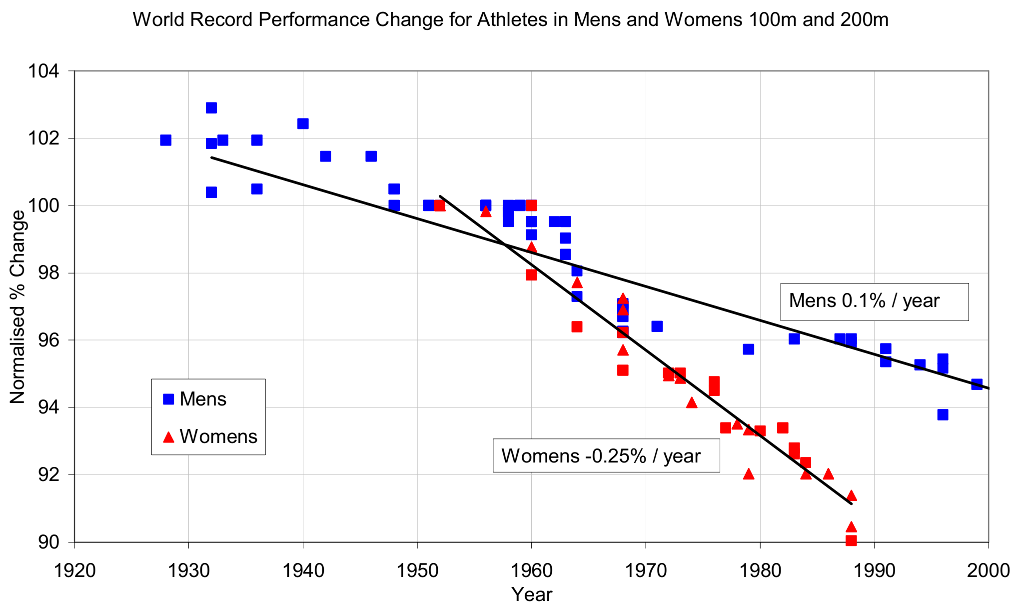
Pace of Development

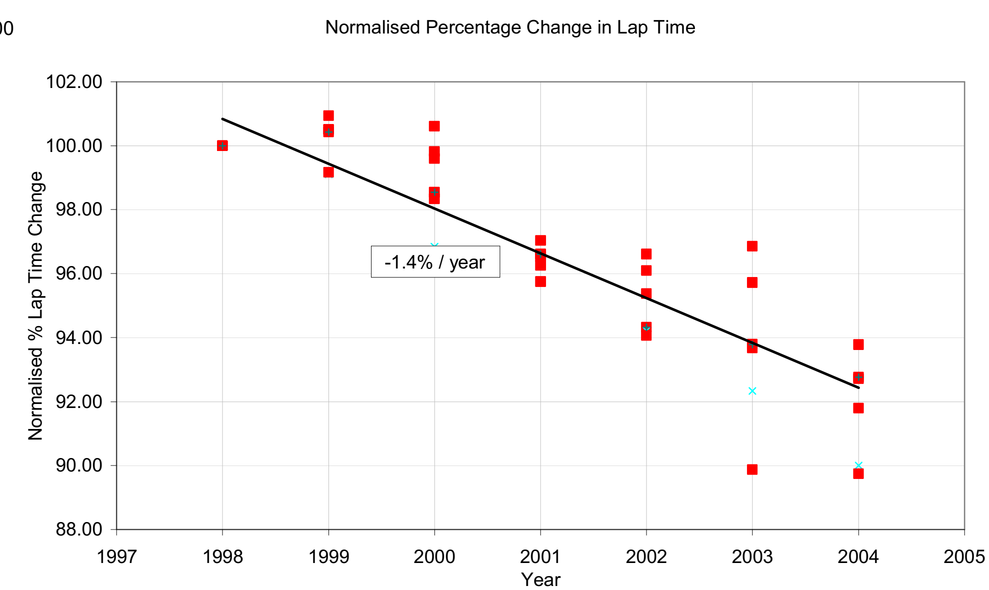


100m & 200m World Record

Vs.

F1 Lap Time Decrease

0.2% vs. 1.4% per year

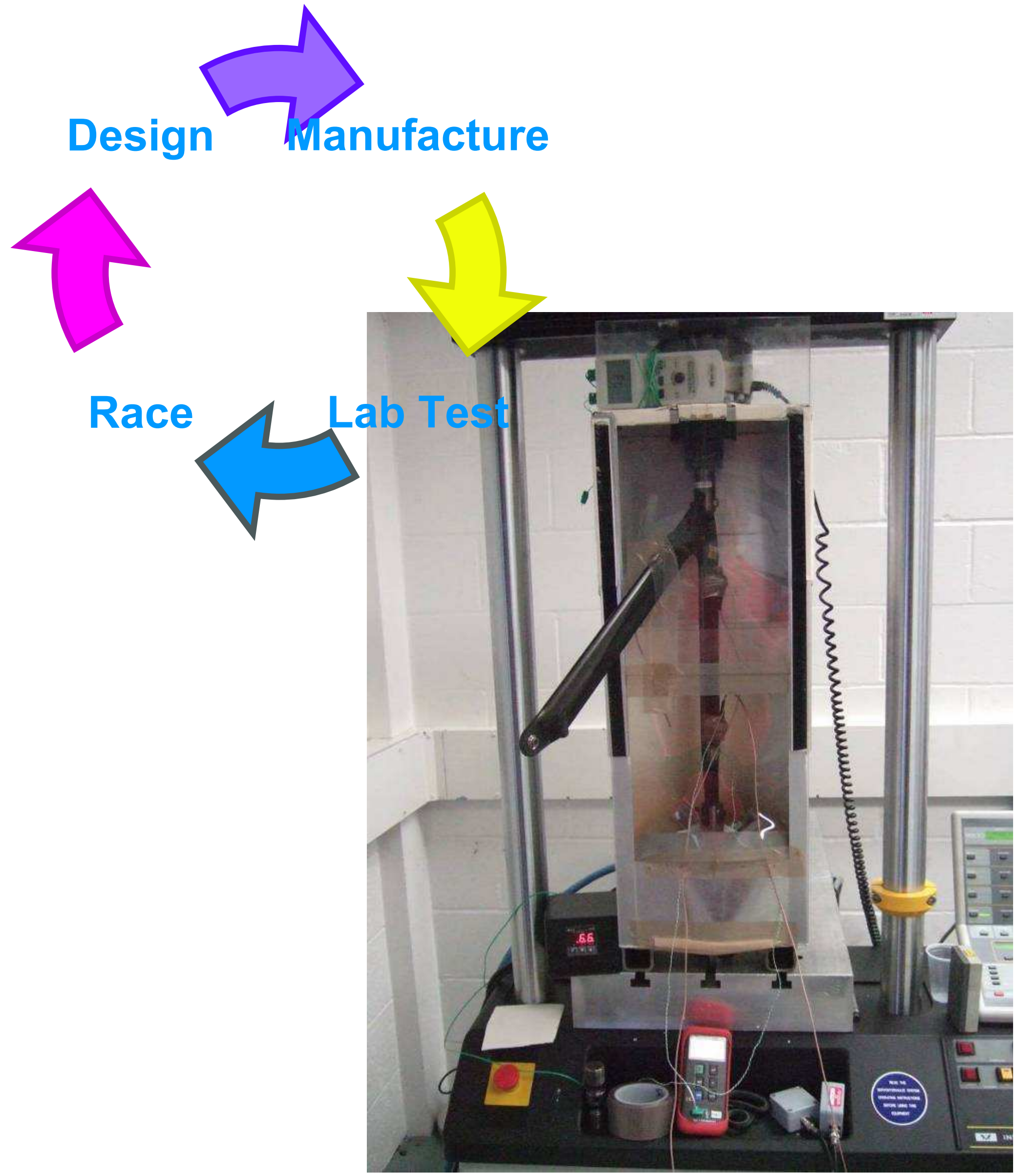


F1 Budgets £50-250m per year

Pace is driven by innovation

F1 Innovation Cycle

- Ideas pipeline
- Up to 20 iterations of parts per year
- "Prototyping competition"
  - Volume < 5 off
  - Design / Manufacturing Cycle 8-14 weeks
- Sign off techniques allow parts to be delivered straight to the track
- High risk, high visibility of failure (500m viewers worldwide)



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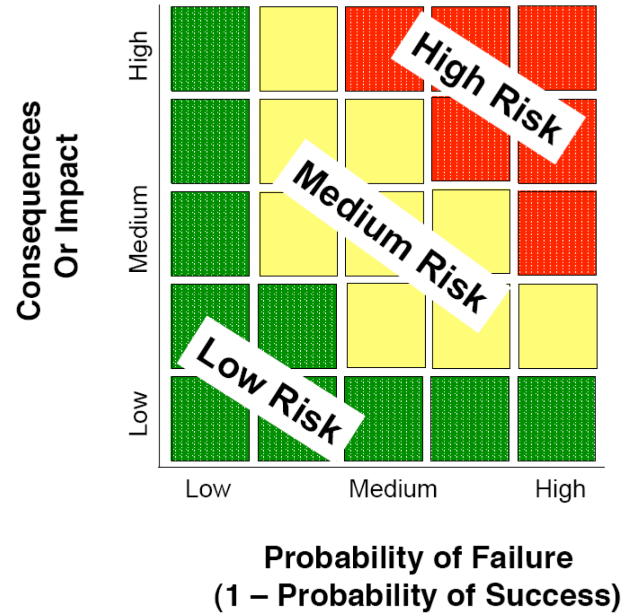
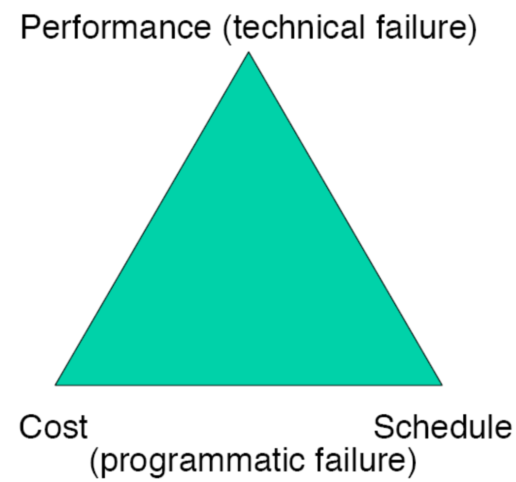
Risk / Failure

- Is F1 really high risk?
- Risk is composed of 2 elements
  - Uncertainty (probability of success/failure)
  - Consequences (of an event)
- Risk Assessment Matrix
- Failure types
  - Performance - Technical Failure
  - Programmatic - (cost, timing)





Pictures: "Estimating the Risk of Technology Development", Dr. Alan W. Wilhite, Center for Aerospace Systems Analysis (CASA)

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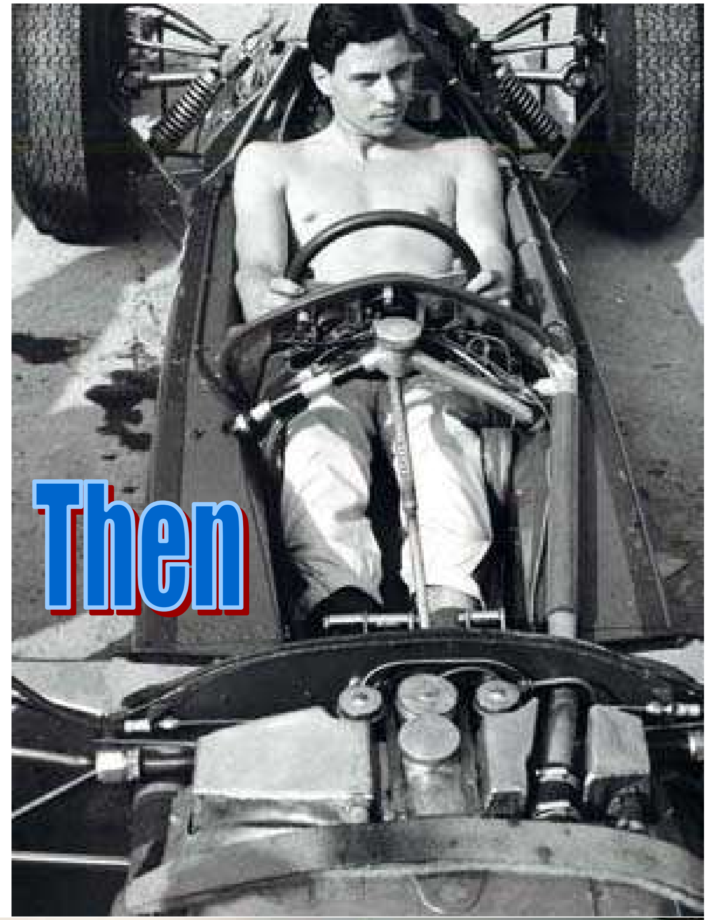
Risk in F1

- Has risk changed?
- YES!
- *Success is 99% Failure - Soichiro Honda*
  - "Why haven't you failed anything yet, you're not trying hard enough"
  - Typical engineers response/questions "How many chances do we get before people panic?!"



Photos: Jim Clark at Lotus and Red Bull factory 2009

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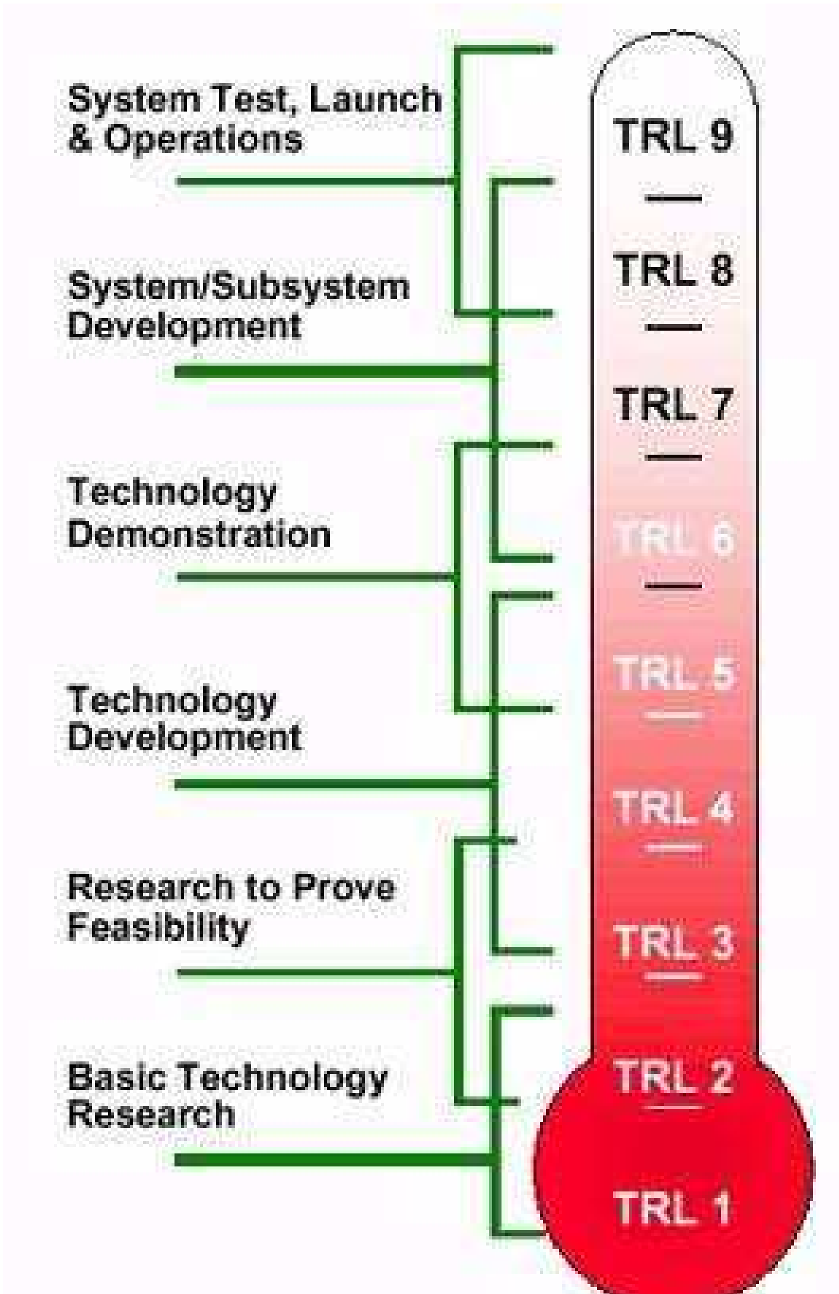

NASA Technology Readiness Levels (TRL)

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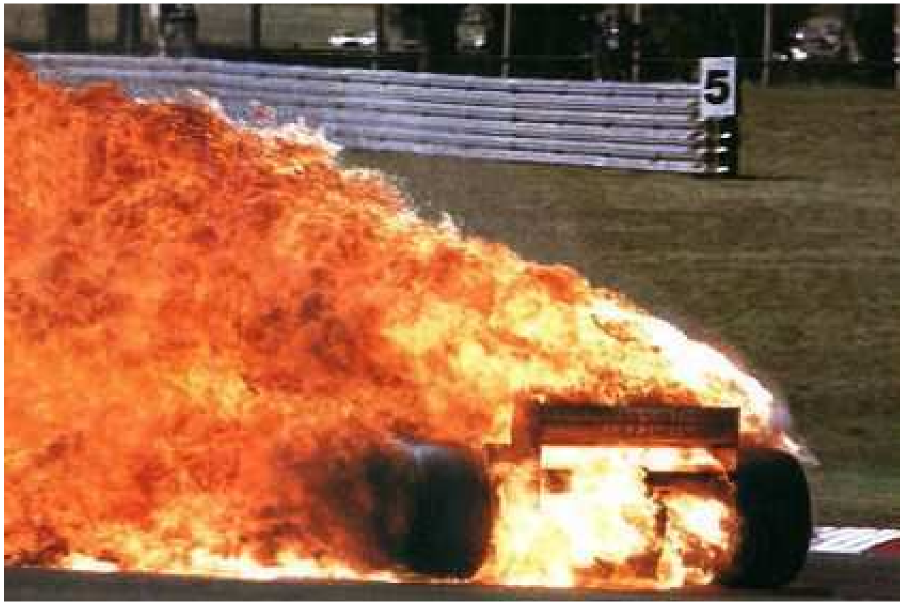
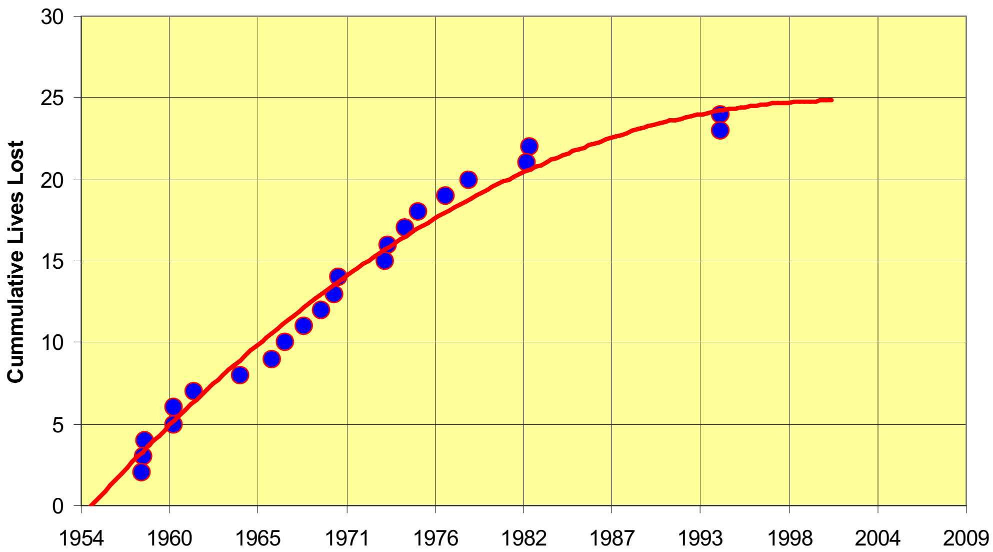
F1 Safety Progression

- Fire extinguishers
- Seat Belts
- Helmets
- Monocoque





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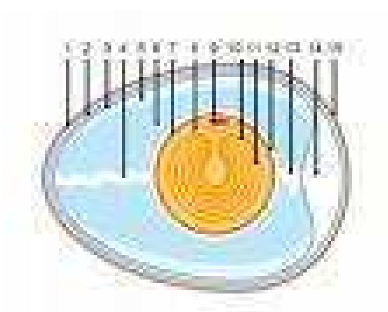
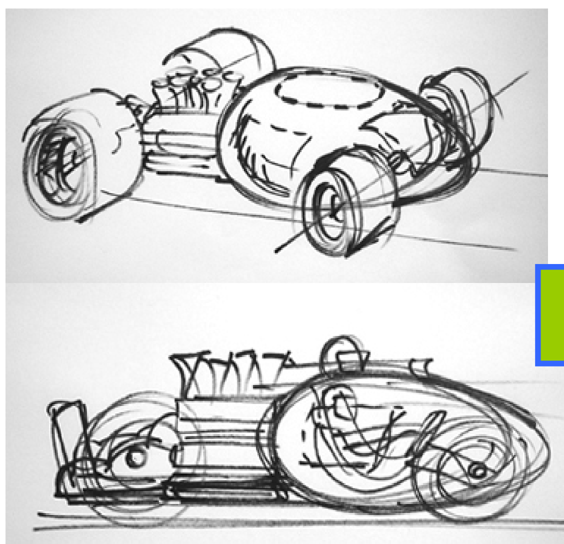
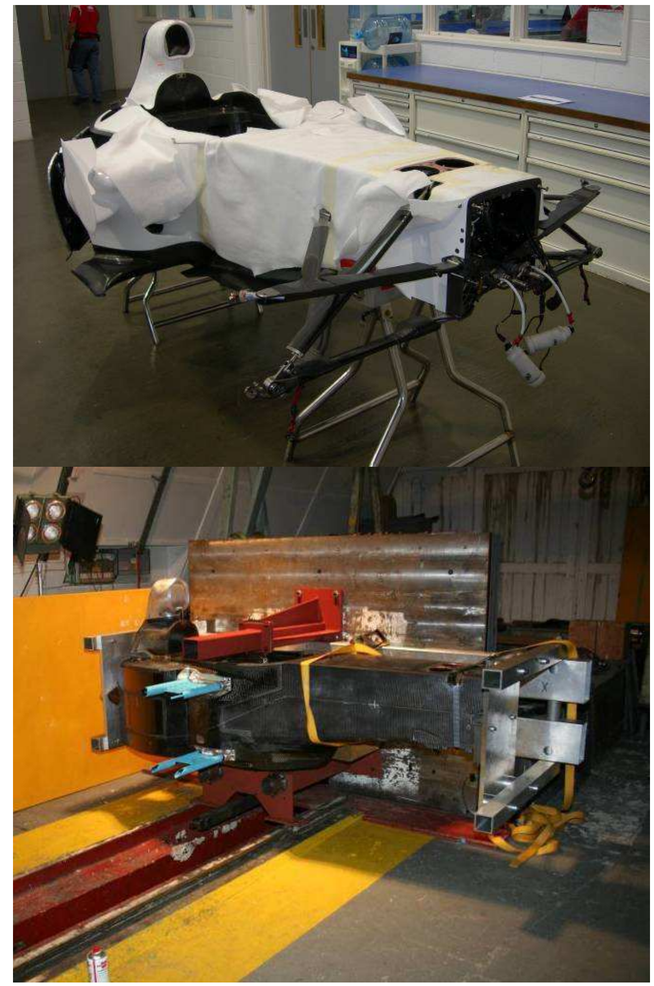
Monocoque Development

- Mono – single
- Coque – shell example = egg
- Cocoon for the driver
- Seatbelts
- Internal padding







Sketches from “The Egg of Columbus”, thechaparralfiles.com

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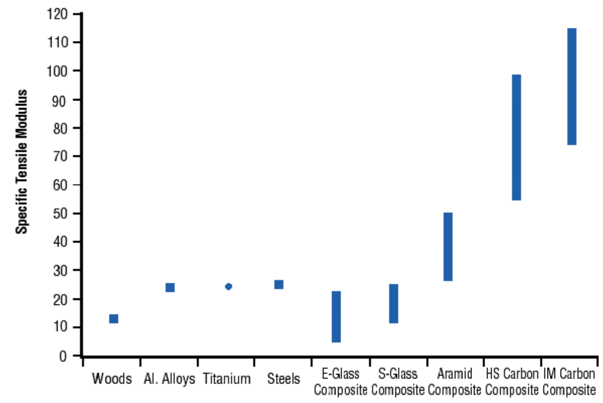
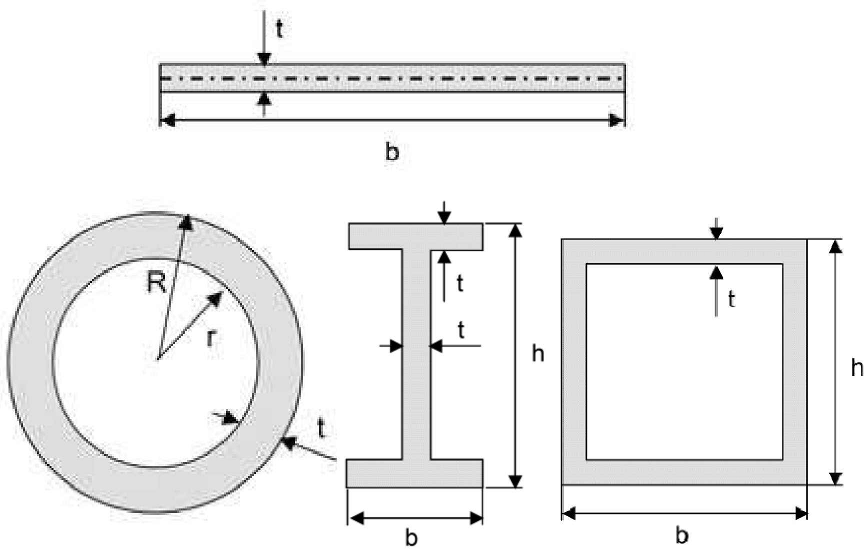
Why Composites?

- Specific Modulus
- Geometric Efficiencies
- Manufacturing
  - Late calls
  - Intricate shapes





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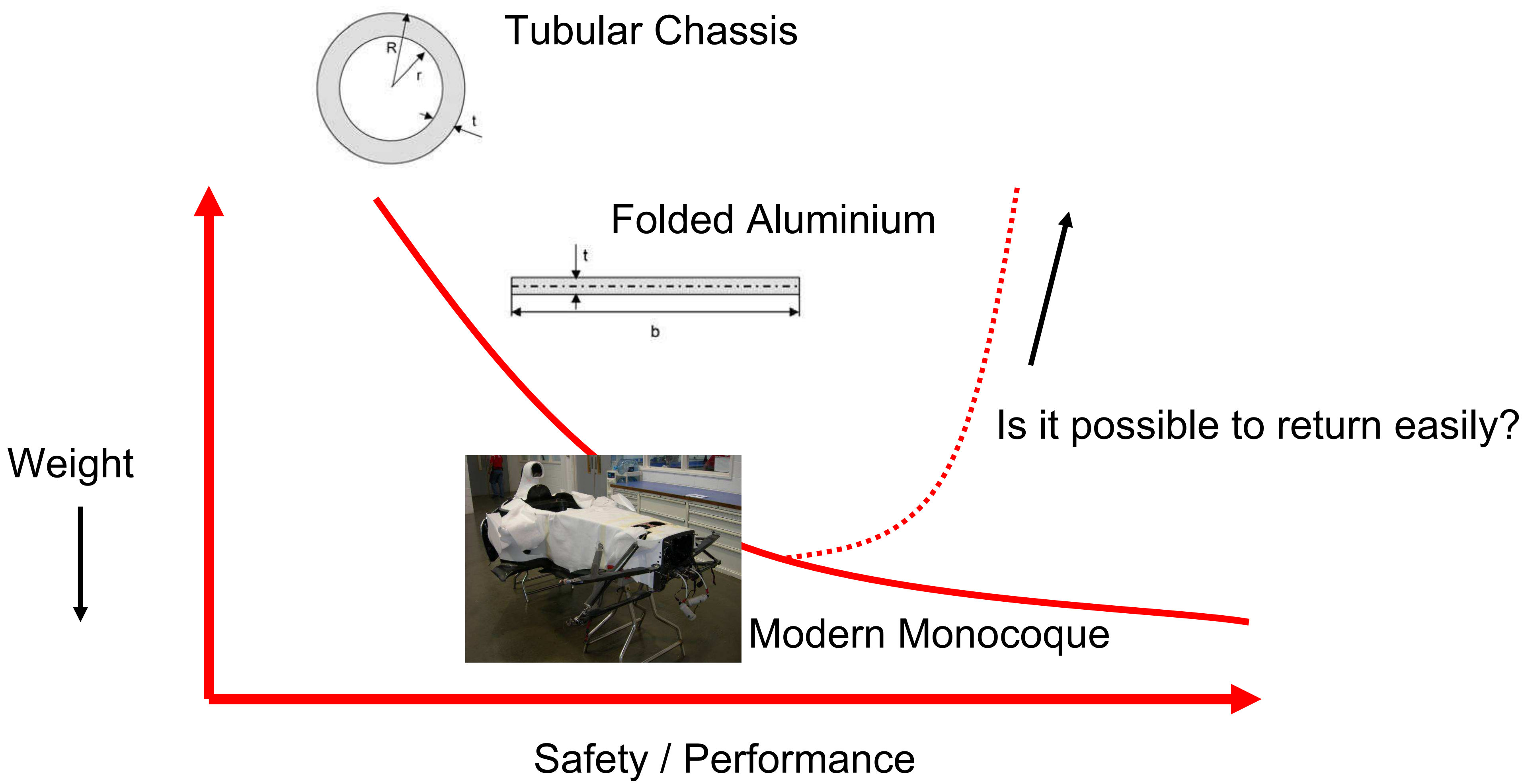
No Return?



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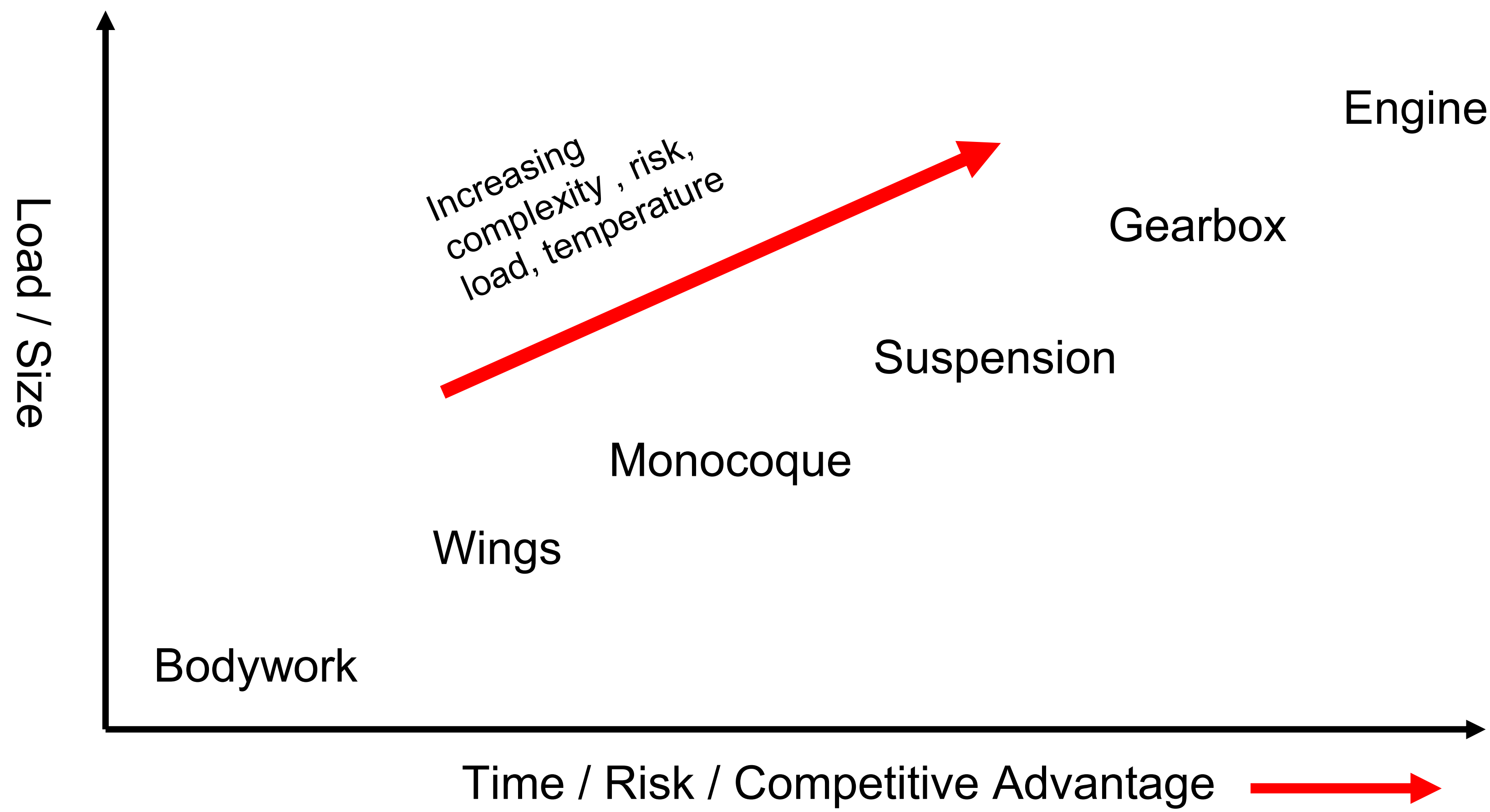
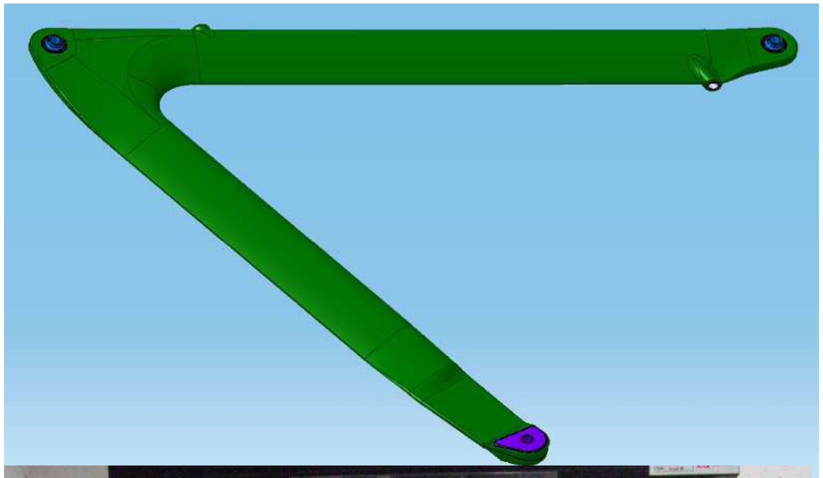
F1 - Evolution of Carbon Substitution



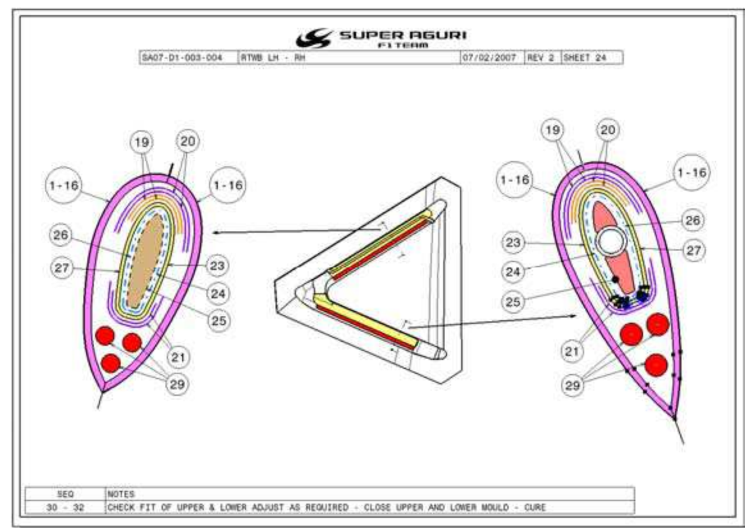


Rear Top Wishbone

Problem:

- Aerodynamics – smallest size possible
- Temperature – rear of the car near exhausts
- Cost – reduce the price of flexures
- Stiffness – reduce the joints
- Strength – Make it one piece

Weight Reduction
Original Steel Part - 100%
Carbon and steel - 52.7%
Full carbon - 41.7%



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787 Dreamliner

- High Composite Target
- High risk
- Very public
- Recent problems will make it harder to return – Mitsubishi has responded with aluminium return
- Why should there only be 1 chance at failure?
- Consequences are high
- Can motorsports provide an “Open Source” innovation opportunities?

Blue Sky Thinking

- Cognitive differences
- “Fail often, fail early”
- Open innovation
- “Killer App” – could F1 provide in composites?
- Can there be a way to provide the necessary learning in a different sector?
- If so, can aerospace truly benefit from motorsports and sports?

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Summary

- Composite substitution in Formula 1 has gone further than most industries
- The benefits to safety have been large
- There are many examples of parts that would face large performance losses if returned to metals – the monocoque is one example
- Innovation in F1 and other sports can transfer to aerospace reducing risk