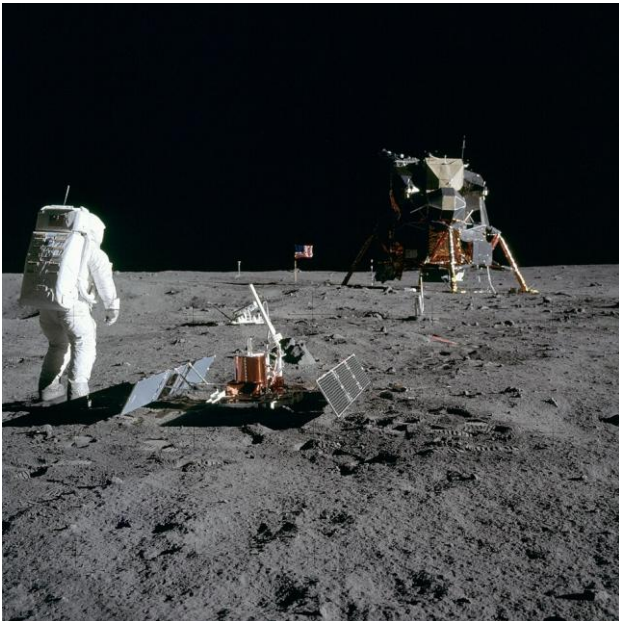


Materials and Manufacturing (Linking Atoms and Money)

Darren J Hughes - WMG

20th July 2026

Pre-University Summer School, University of Warwick.



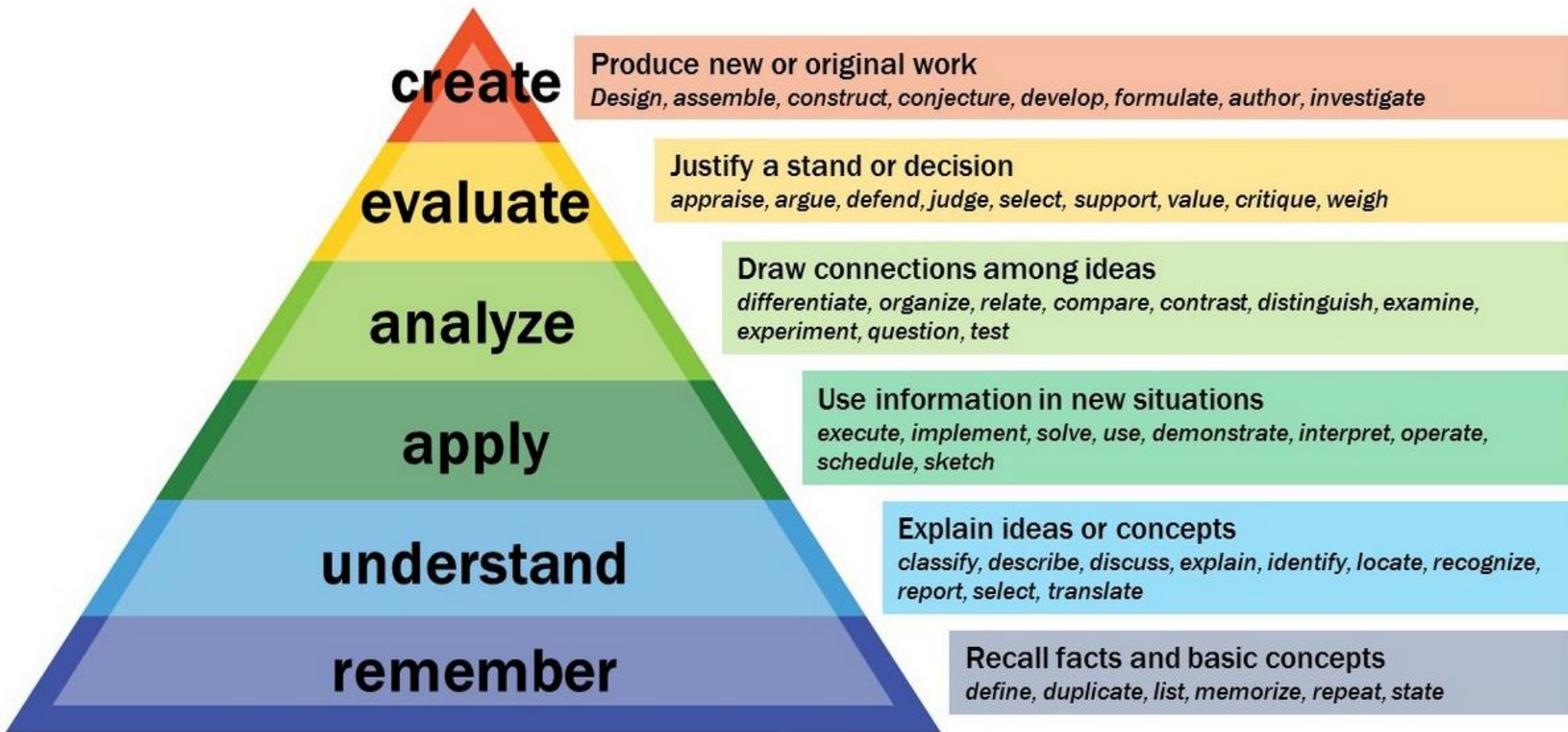
20th July 1969 – Apollo landing



20th July 1903 – First Ford manufactured

What is learning? – Blooms Taxonomy

The Taxonomy of Educational Objectives, Part 1. Benjamin S. Bloom (Chapter 1) Longmans, London, 1956.



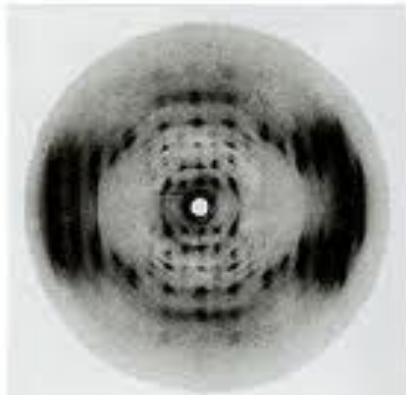
Why am I here?

Why am I here?

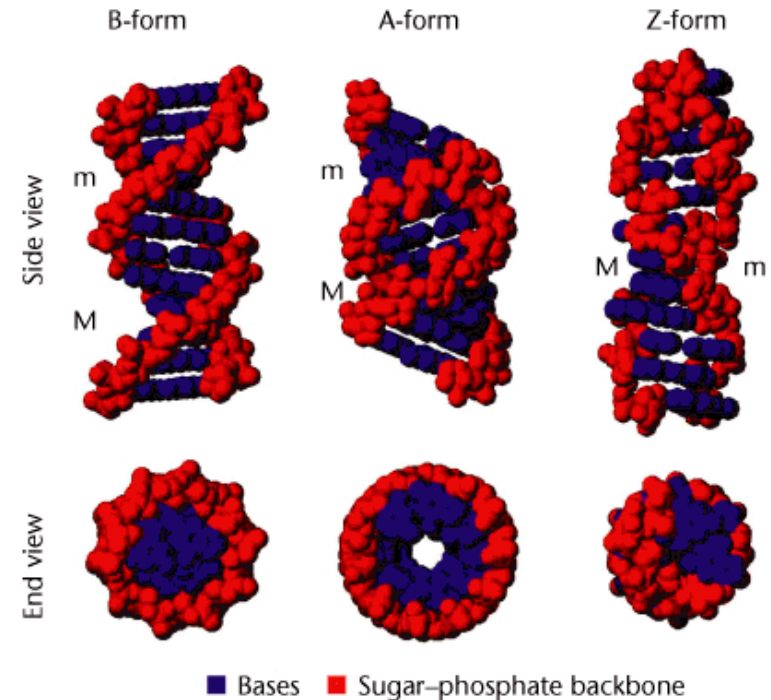
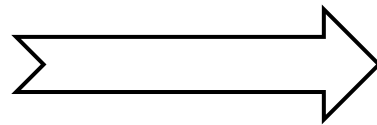
Background – BSc (Hons) Physics and Computing

➤ PhD: Structural biophysics

Conformation of DNA molecule



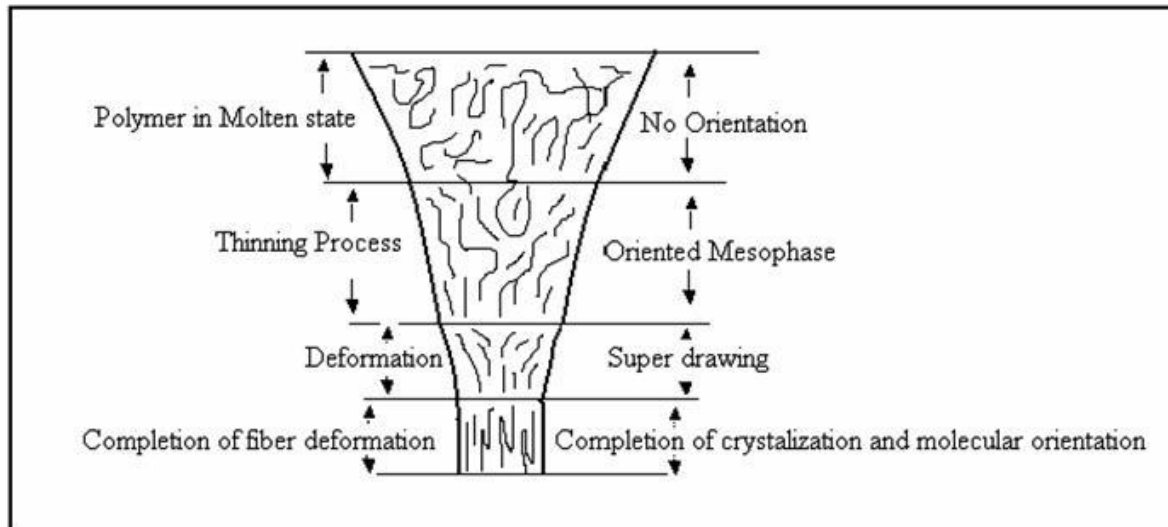
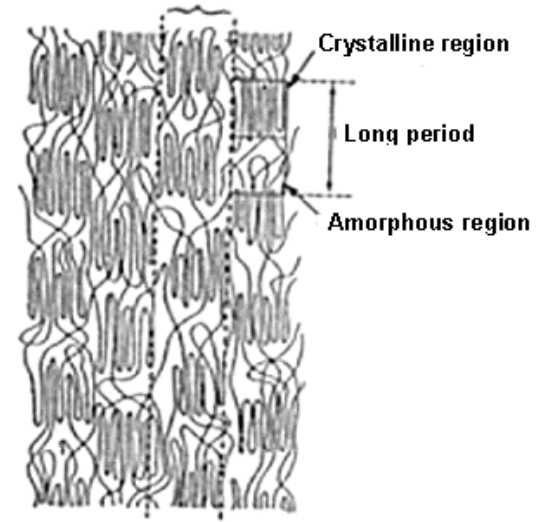
Courtesy of the Cold Spring Harbor Archives. Noncommercial, educational use only.



Background

➤ Polymer science

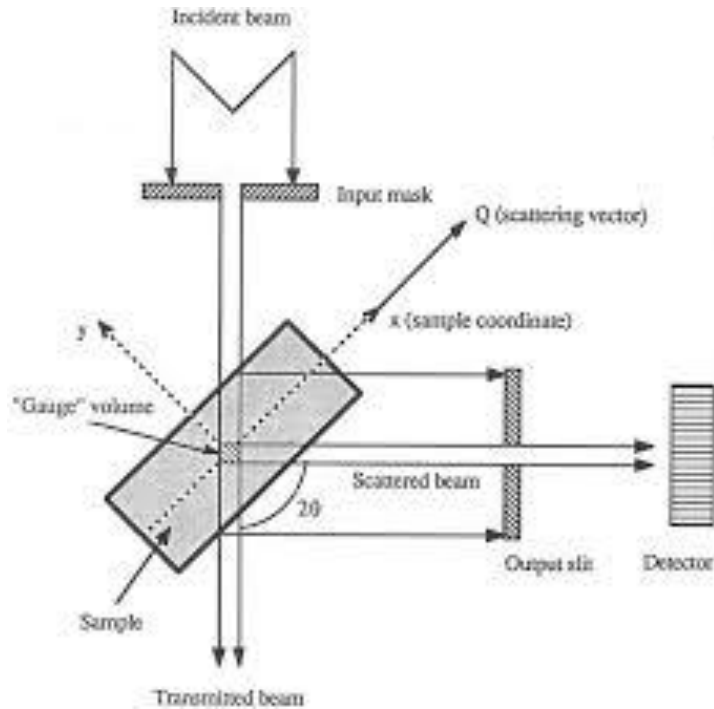
Rapid drawing of PET (coke bottles)



- Residual stress determination – NDT
 - mainly metals (steel, nickel, titanium.....)
 - composites + polymers
 - high value manufacturing

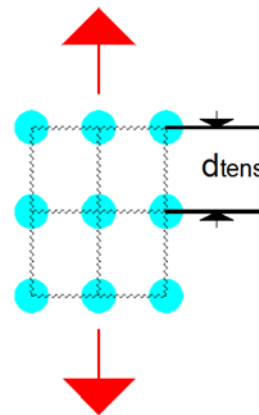
Previously based at Institut Laue Langevin in Grenoble, France.



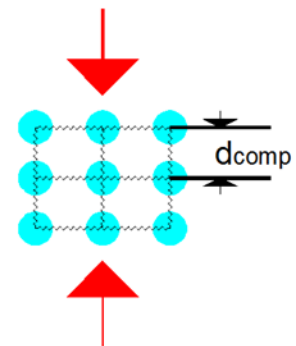


Residual stress scanning using X-rays and neutrons

- The crystal lattice is like an 'internal strain gauge'



TENSION



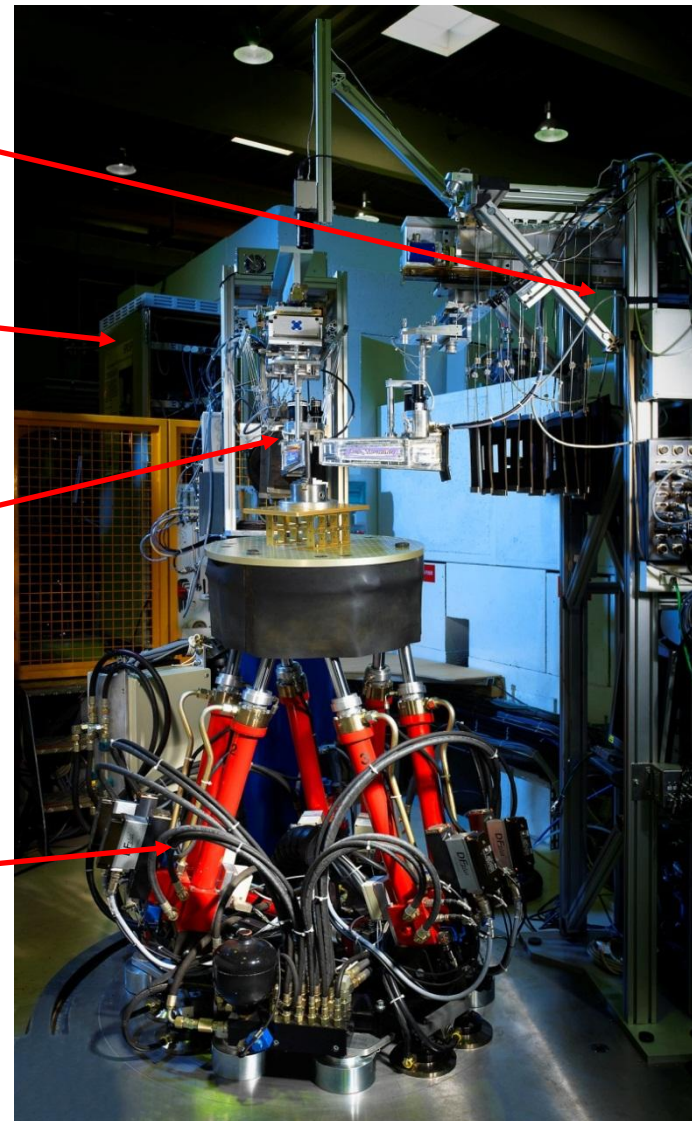
COMPRESSION

Monochromator – beam delivery

Detector

Beam optics

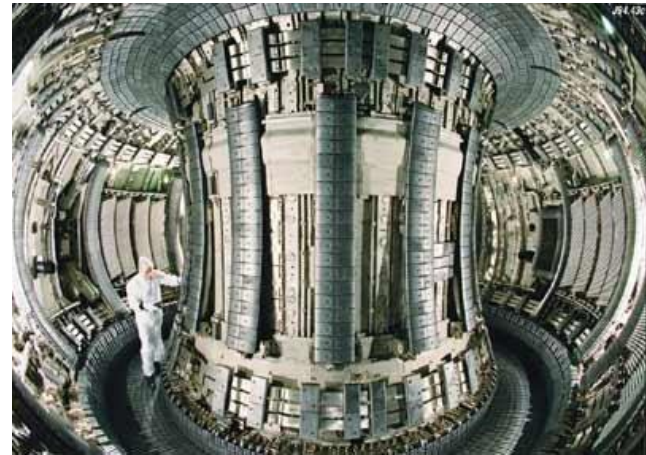
Sample platform
(x,y,z)



Example - Development of breeding blankets for fusion reactors: ITER (fusion reactor) project.

Plasma-facing (blanket)

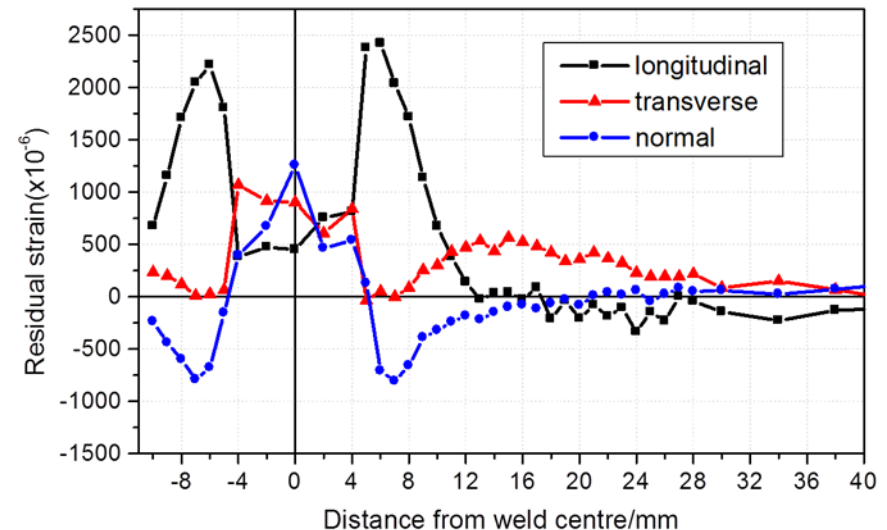
- Steel
- Low activation
- High fatigue load (thermal stress)
- RS important to understand



Laser welded assembly with integral cooling channels



[Welds for blanket modules: residual stress in a laser welded EUROFER assembly. D.J. Hughes, E. Koukovini-Platia and E.L. Heeley. Fus.Eng.Des. 2014]



Lightweighting – materials and manufacturing

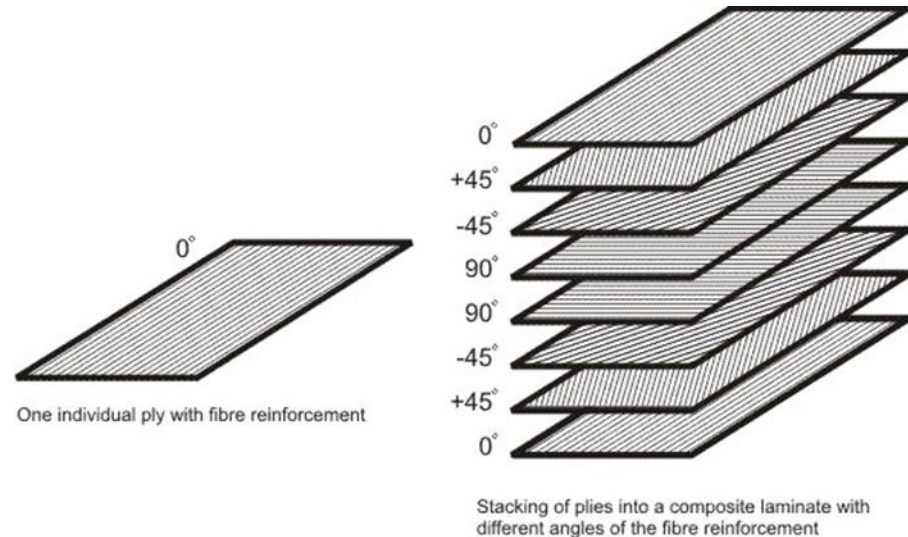
- Composite manufacturing – vehicle manufacturing projects

thermoplastic/thermoset composites

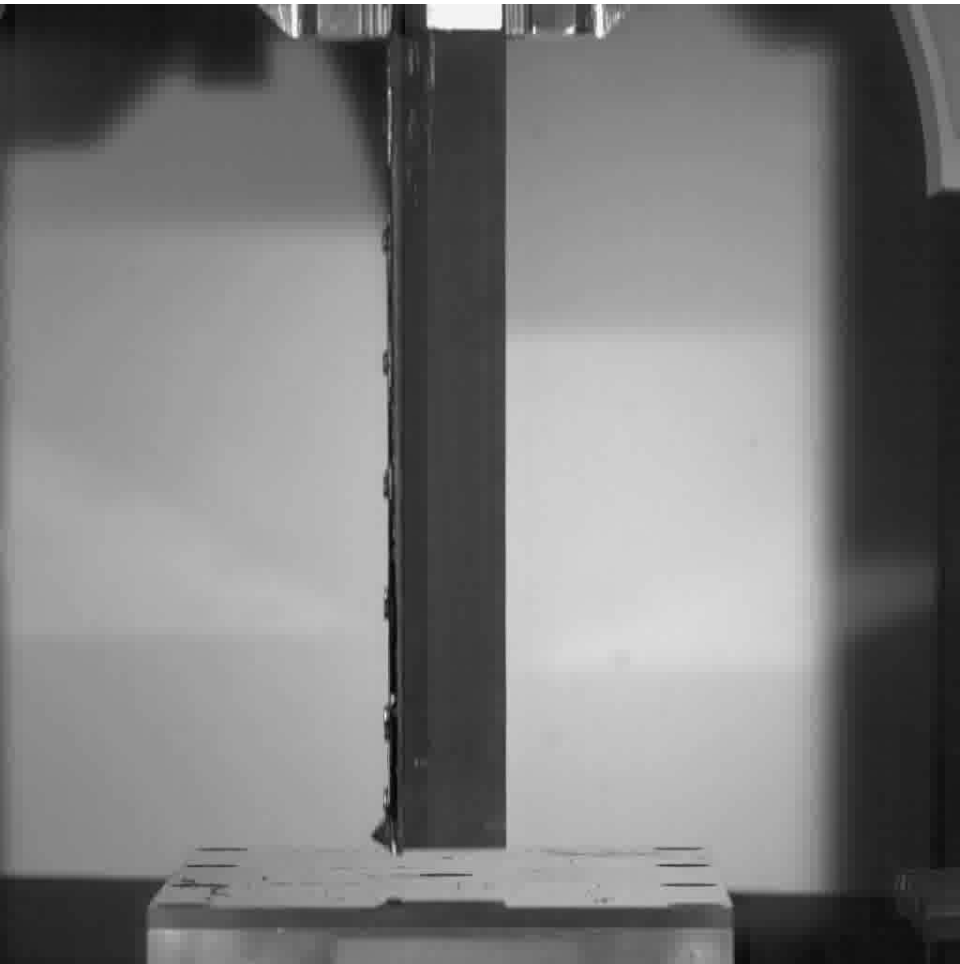
How can we join composites and multi-materials?



Through-thickness

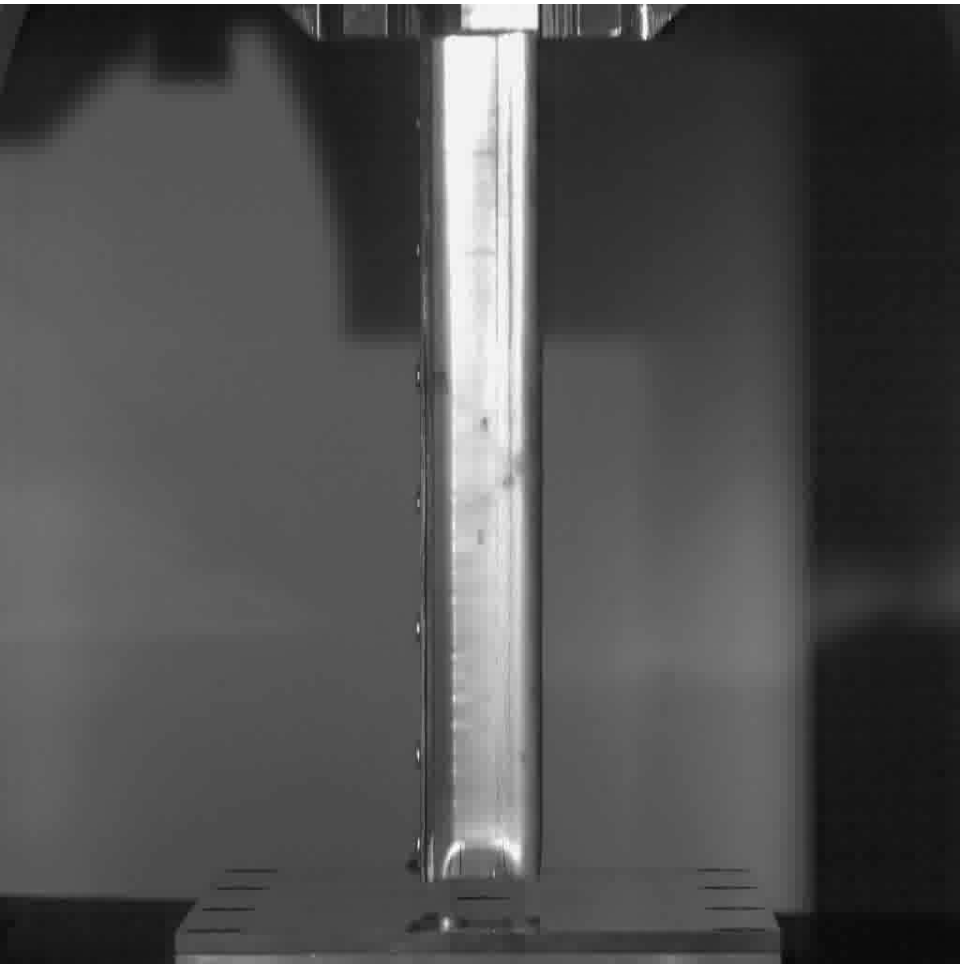


Front longitudinal – high speed crash performance



5400 fps
1024 x 1024
+00:00:00.000000
9_1
14.7 m/s
10 mm saw cut

1/5400 sec
frame : 0
Date : 2011/8/31
Test 1
8 kJ



5400 fps
1024 x 1024
+00:00:00.000000
8_1
14.7 m/s
Claussian System

1/5400 sec
frame : 0
Date : 2011/9/5
Test 1
8 kJ





+

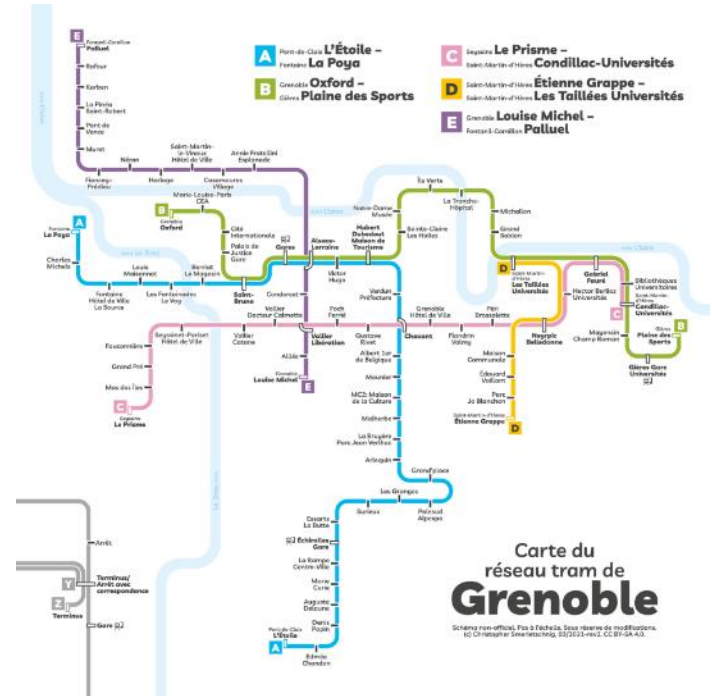




1939 Broadgate, Coventry



Grenoble, Isere.



Population:
Grenoble : $\approx 500k$
Coventry : $\approx 400k$

T The Times

Final cost of Edinburgh trams scheme will be £1 billion

Euan Mackenzie, QC, counsel for the inquiry, said that on top of the official £776 million price tag there had been £44 million of tram-related ...

14 Dec 2017



£ 71 million / km

R Rail Magazine

Manchester Metrolink's new £350 million Trafford Park Line to ...

Transport for Greater
Manchester confirmed the
£350 million Trafford Park Line (TPL) will open seven months earlier than pla...

27 Dec 2019



£ 63 million / km

The **cost** of building the 11km long **Midland Metro extension** from Wednesbury to Brierley Hill to the north-west of Birmingham has risen by £50M to £449.5M. The increase was announced in board papers ahead of a West **Midlands** Combined Authority (WMCA) Investment Board meeting next week. 7 Mar 2019.



£ 41 million / km



Innovating in Affordable Light Rail



VLR – Very Light Rail: A new urban mobility concept in Coventry

by Liam Hughes



The first vehicle in Coventry | © Coventry City Council

In London, Birmingham and Manchester, urban rail projects have encouraged thousands to take zero emission journeys instead of jumping in the car. But for many cities, urban rail is simply not an option – the costs are too high, the streets too narrow, and existing infrastructure presents too costly a barrier to remove.

Coventry is building something different; a new urban rail system which could allow other similarly sized cities and towns to benefit from urban light rail.

Dubbed Coventry Very Light Rail (VLR), Coventry City Council is working with researchers and engineers from WMG at the University of Warwick, to develop a new kind of vehicle, alongside a new track, to enhance the business case for urban light rail in places like Coventry.

The vehicle

The new vehicle, pictured, differs significantly from trams and is about the same size as a single decker bus, having roughly the same capacity – 56. It's designed to have a 15m turning circle, meaning it can get round the tight corners in Coventry's roads. It's battery powered, meaning it's locally zero emission and doesn't need overhead cabling. Recharging is done via pantograph at Furry&Frey fast chargers along the future line. And by making use of lightweight materials, it puts less pressure on the road, enabling the design of an entirely new kind of track.

<https://www.urban-transport-magazine.com/en/vlr-very-light-rail-a-new-concept-for-coventry/>

Road milling (March 2023)



Slab alignment



Bedding layer



Rail placement



Asphalting



Finished article TRL 8



Final stage of research and development phase: June 2025

250 m full demonstrator open for public use



What is **Manufacturing**, what do we manufacture, what do we manufacture with, and what is the point?



