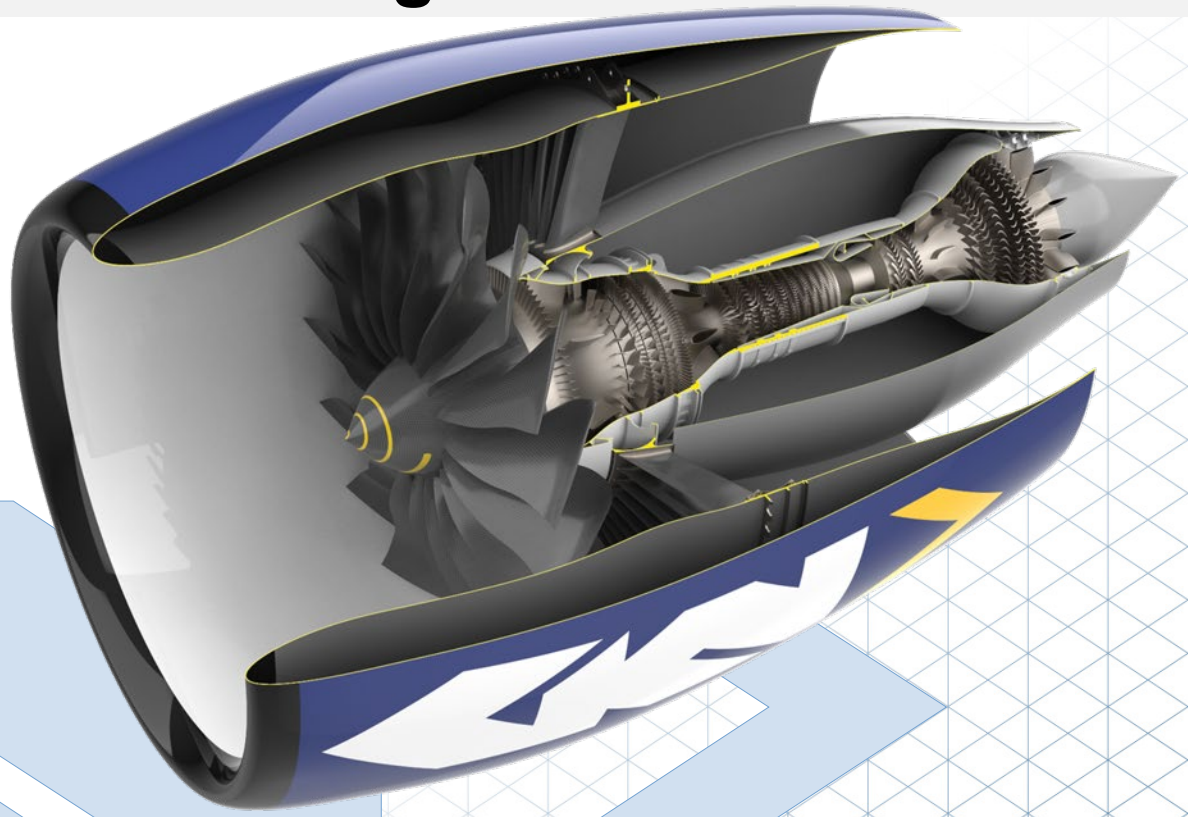
Exempel på nytänkande lättviktslösningar

Anders Sjunnesson, 2019 05 09



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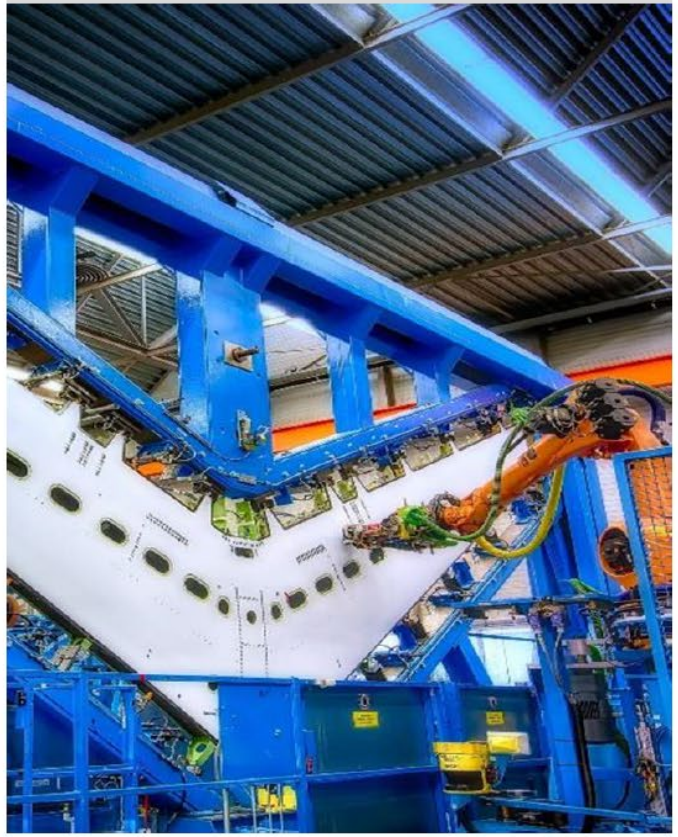
GKN Aerospace: A leading global tier 1 Aerospace supplier

Strong focused businesses, sales £3.6 billion (2017), 17,000 employees.

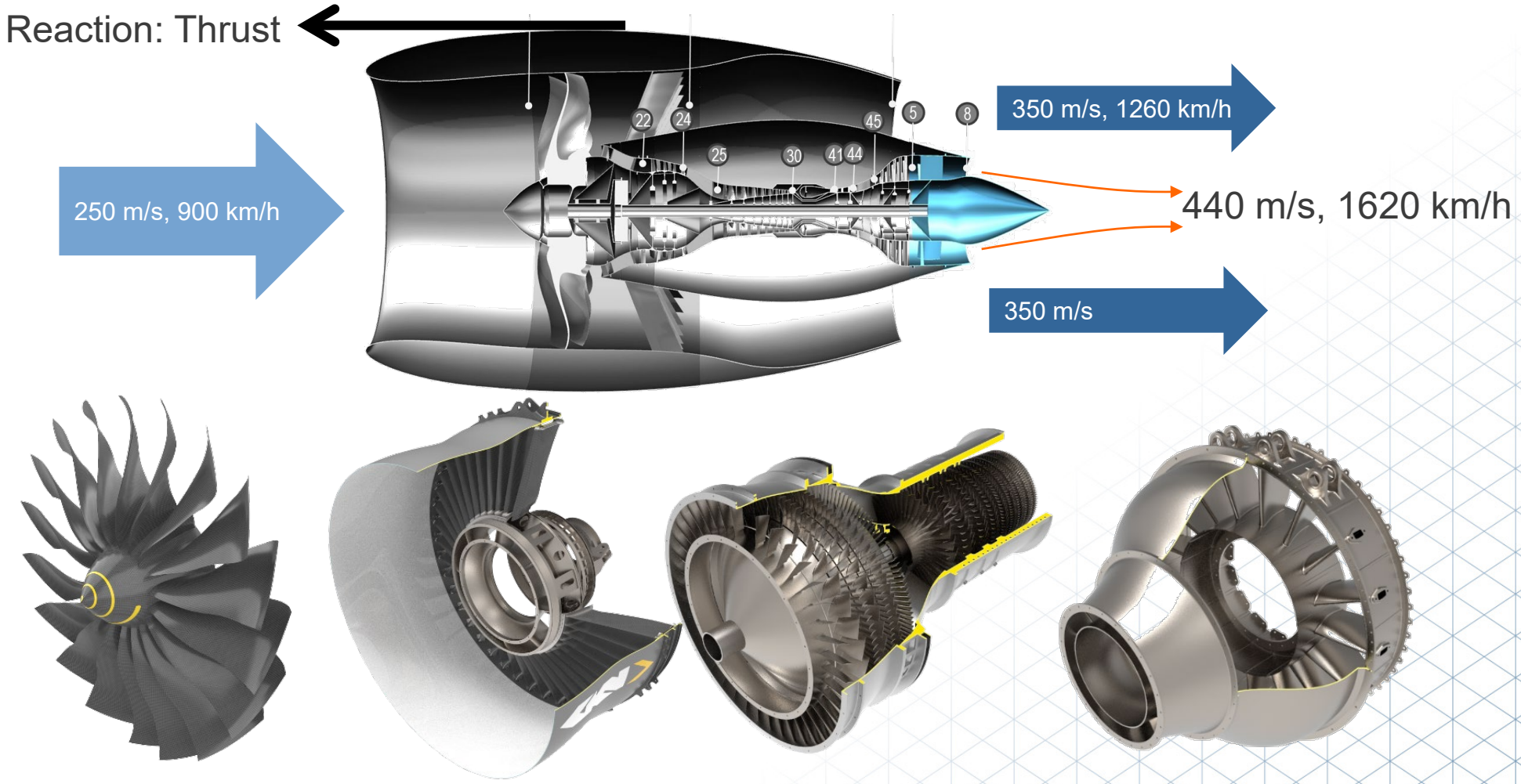
Aerostructures
49% £1.8 billion



Engine Systems
37% £1.3 billion

Special Technologies
14% £0.5 billion

What GKN Engine System does….

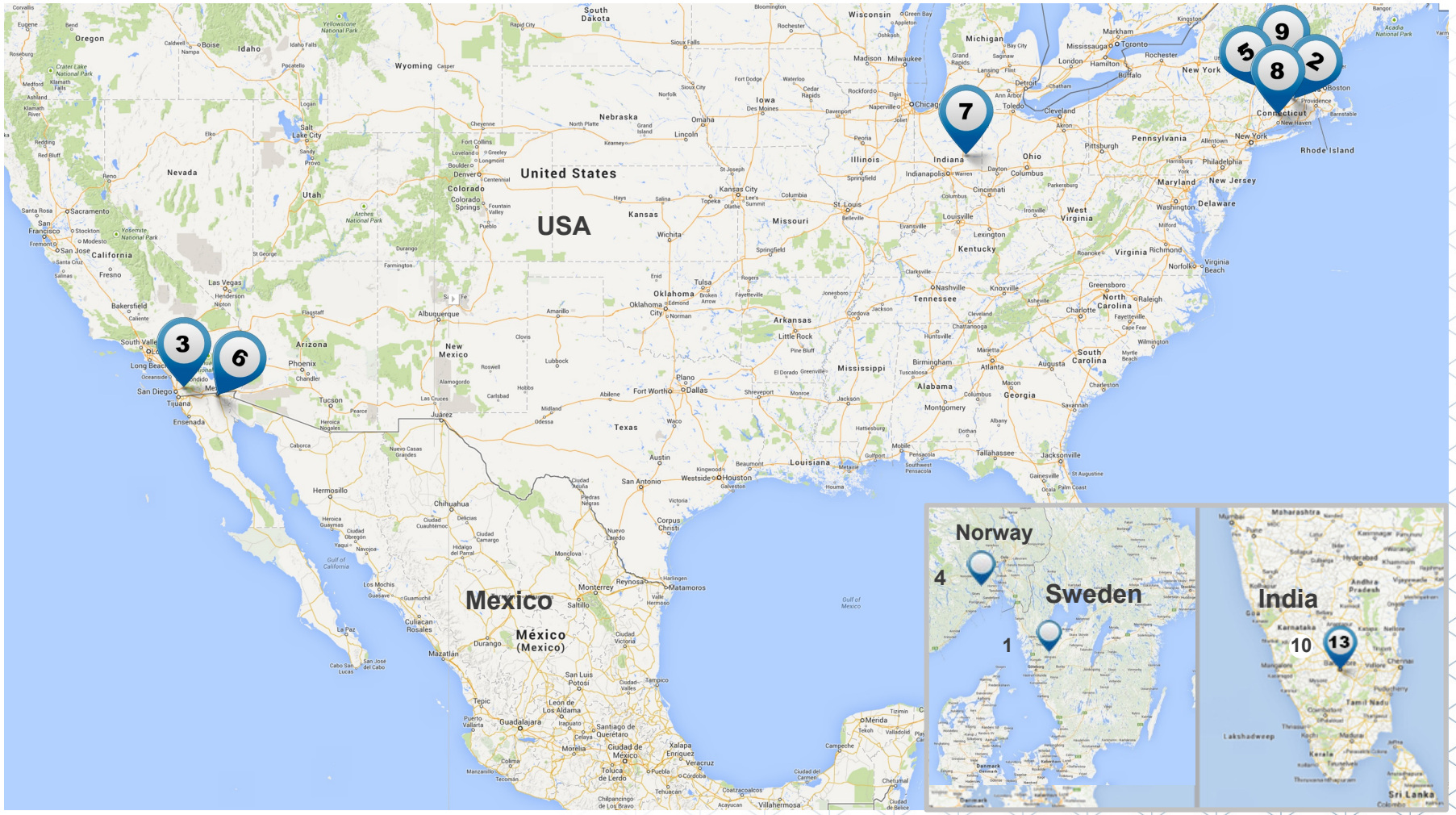


GKN Aerospace Sweden AB Proprietary Information. The information is subject to restrictions on second page.

GKN Aerospace Engine Systems

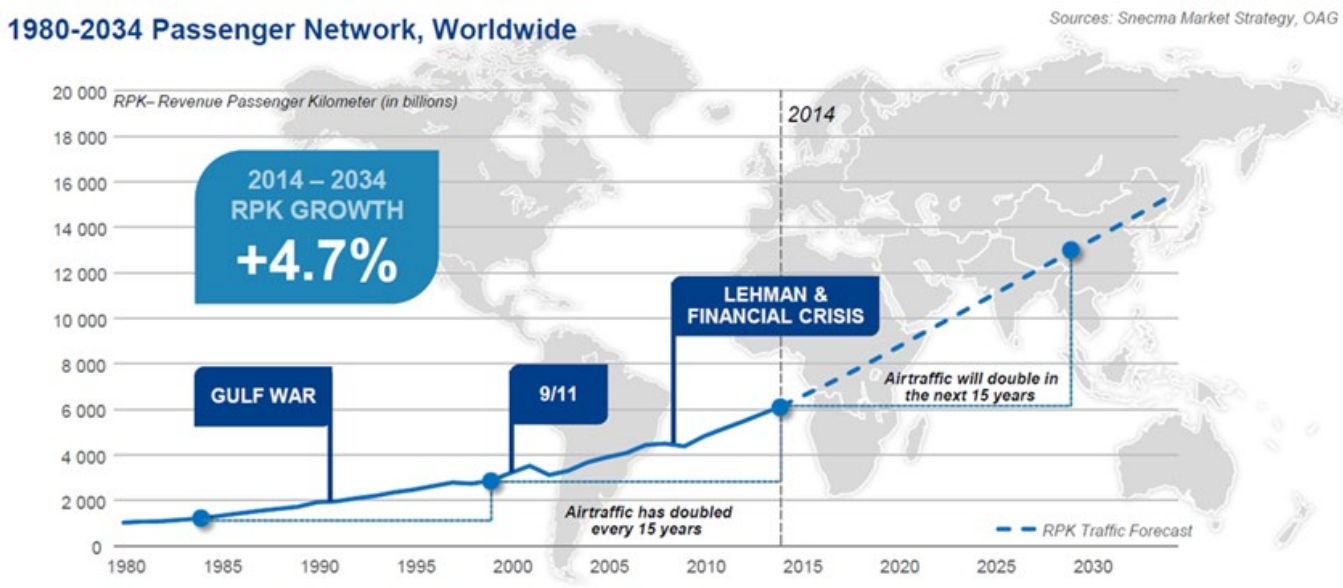
GKN Aerospace Sverige AB

- 2400 anställda, största privata arbetsgivare I Trollhättan.
- Ledning och utvecklingscentrum för koncernens verksamhet inom flygmotor – Engine Systems
- Omsättning 7,3 miljarder kr (i Sverige)
- Global omsättning ~15 miljarder kr



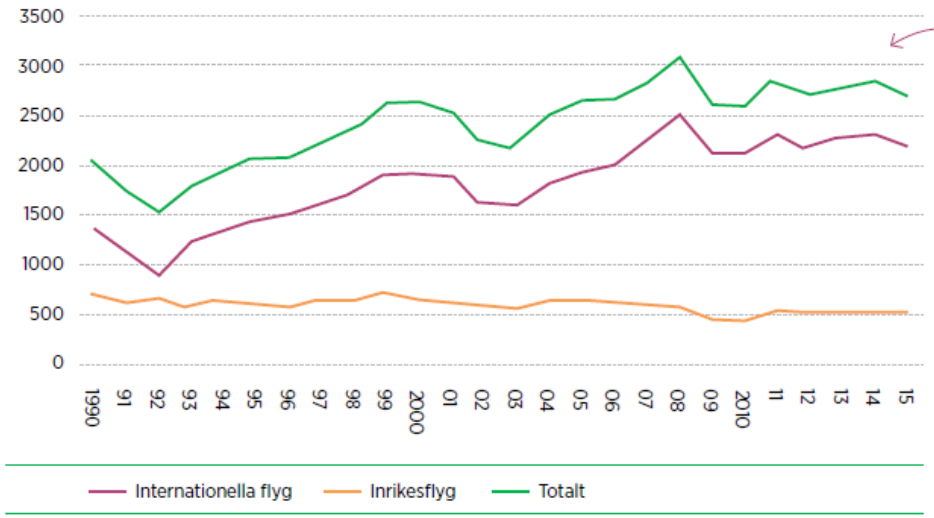
FLYGSKAM – FLIGHT SHAME

- Flyget stod 2015 för 2,5% av all koldioxid från mänsklig verksamhet och 3-8% av klimatpåverkan
- Kväveoxid bidrar till regional försurning, I Sverige kommer ca 4,2% från flyget
- Flygandet förväntas öka 2-3 ggr de kommande 20 åren
- Historiskt har användningen av flygfotogen årligen ökat 2-3%
- Mer än 99,9% av allt flygbränsle kom från fossila källor 2015



And in Sweden?

KOLDIOXIDUTSLÄPP FRÅN FLYGPLAN SOM STARTAR VID SVENSKA FLYGPLATSER (1000 TON)

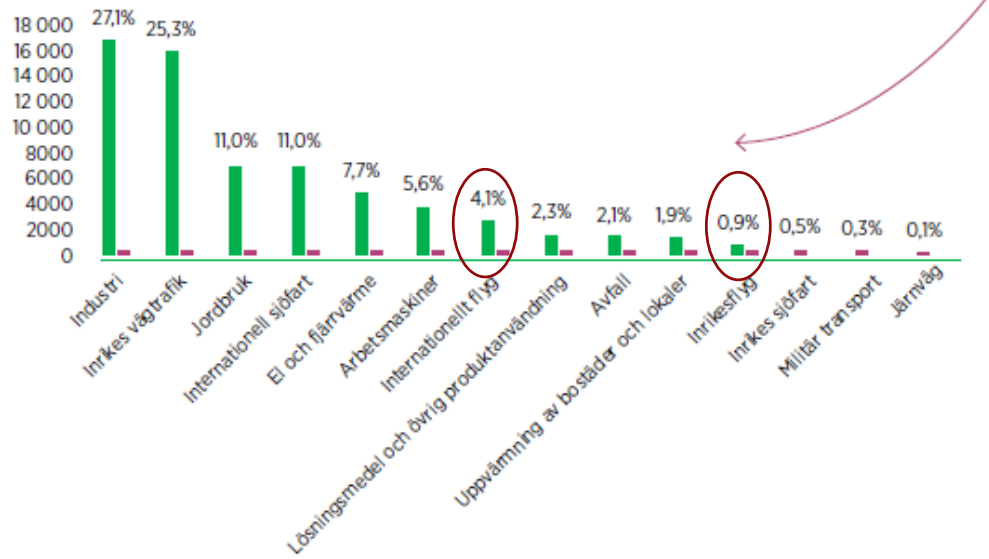


Figur 2: De senaste tio åren har utsläppen (och därmed bränsleåtgången) från flygtrafik som startar vid svenska flygplatser legat i stort sett still.

Källa: Naturvårdsverket

?

SVENSKA KOLDIOXIDUTSLÄPP (1000 TON)



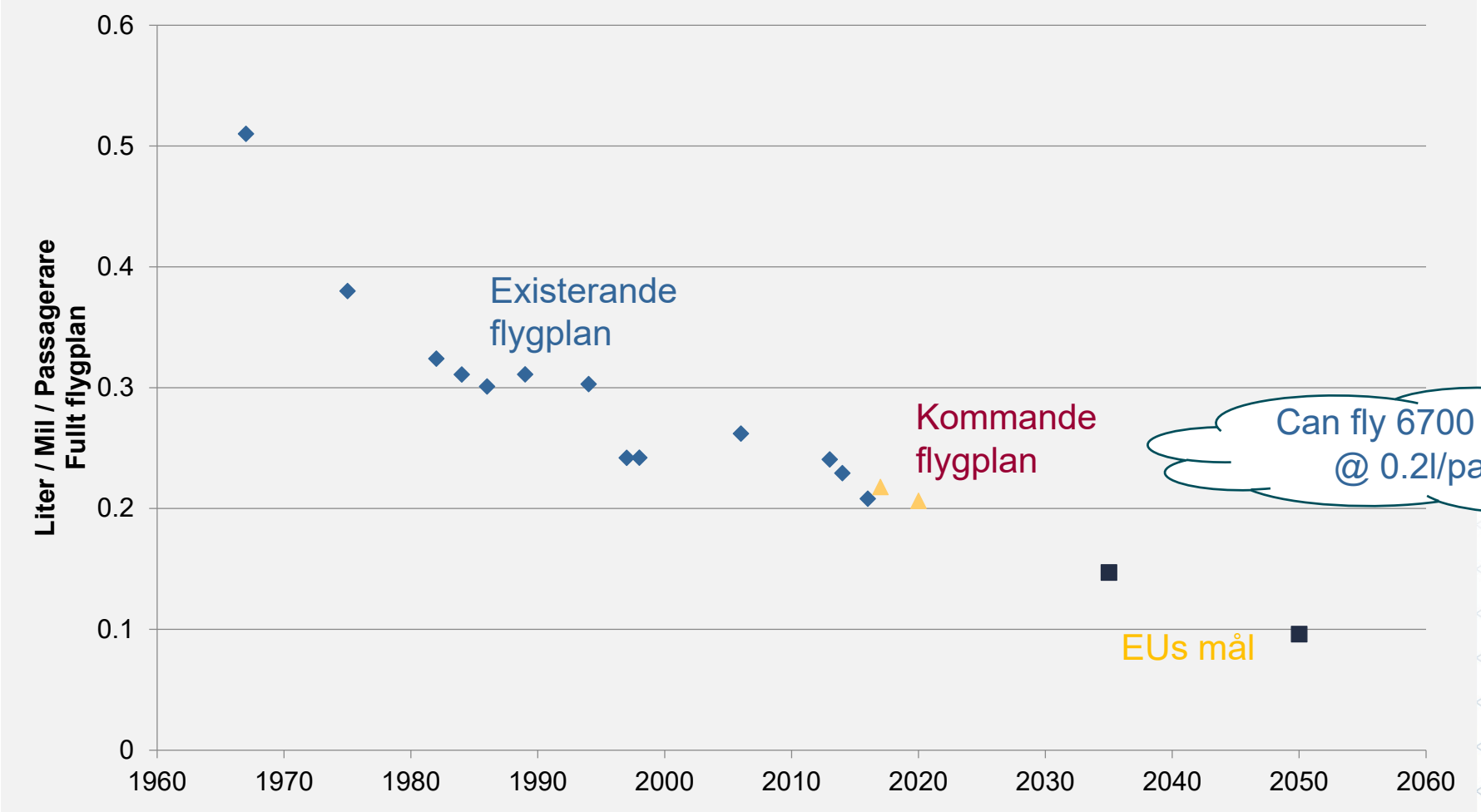
Figur 3: Som vi ser i ovanstående graf stod internationellt flyg för 4,1 % av de totala koldioxidutsläppen under 2016, och inrikesflyget för 0,9 %.

Källa: Naturvårdsverket

Klippt ur:

FÄRDPLAN FÖR FOSSILFRI KONKURRENSKRAFT -*Flygbranschen*

Flygets utveckling - Motor och flygplan



Boeing 737-100, Source:Wikipedia

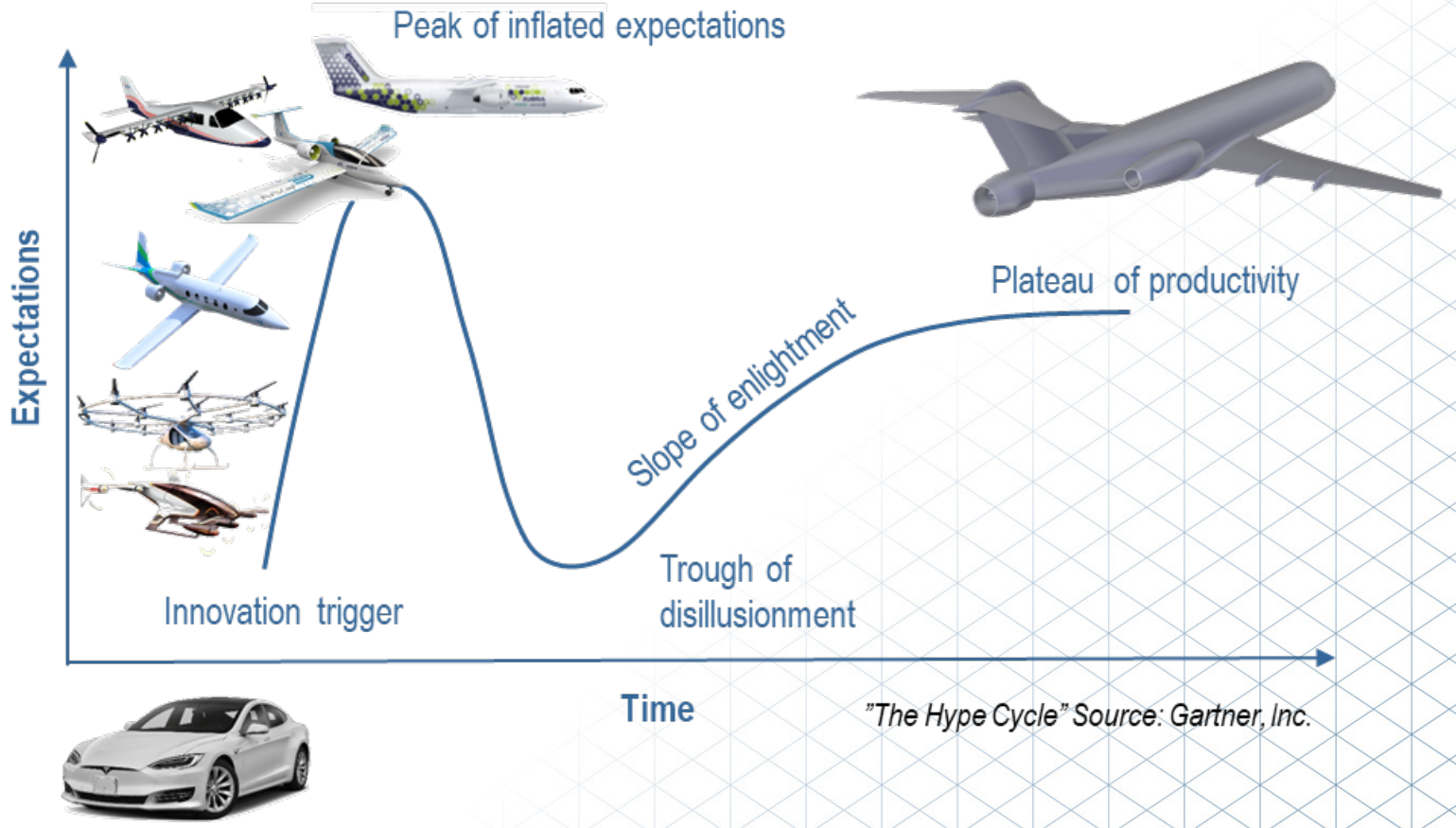
Can fly 6700 km at Mach 0.8
@ 0.2l/passenger km

A320 Neo, Source: Wikipedia

What about electric flight?

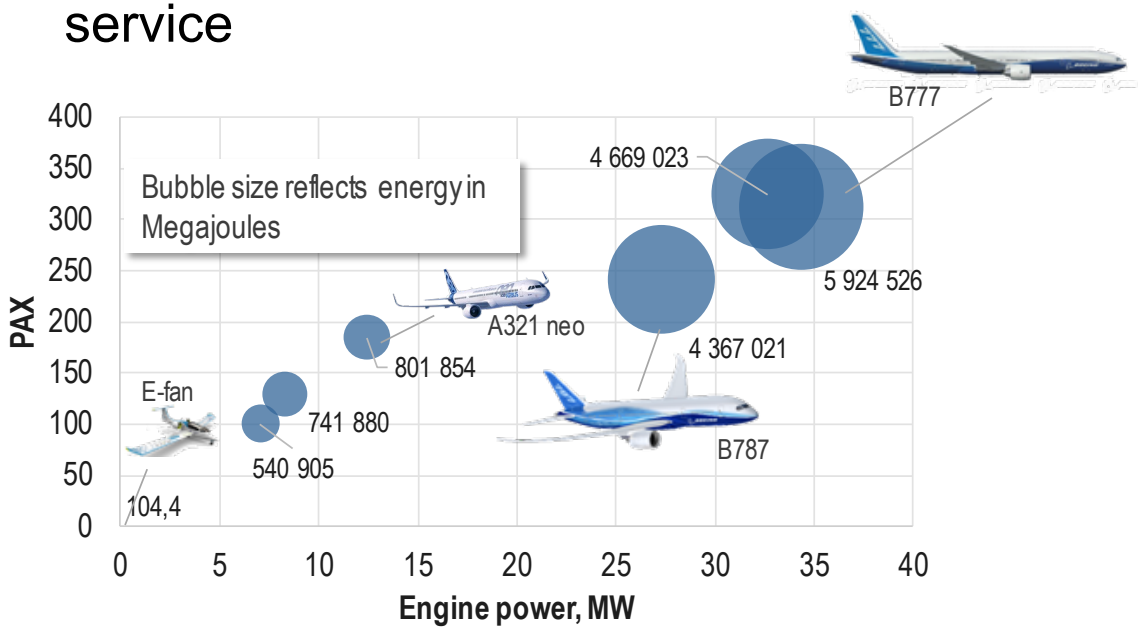
- Electric propulsion is still in its early phases with huge expectations from society
- Must survive the hype cycle
- Hundreds of start-ups around the globe
- Myriads of concepts and “UAV toys” available

The technology “hype curve”



Energy & Power required

- A Boeing 777 has the same energy content as ~16,400 Tesla Model S
- The power of each B777 engine could heat ~3,800 average houses during winter time
- The energy density of kerosene is ~66 times higher than for the best battery systems in service



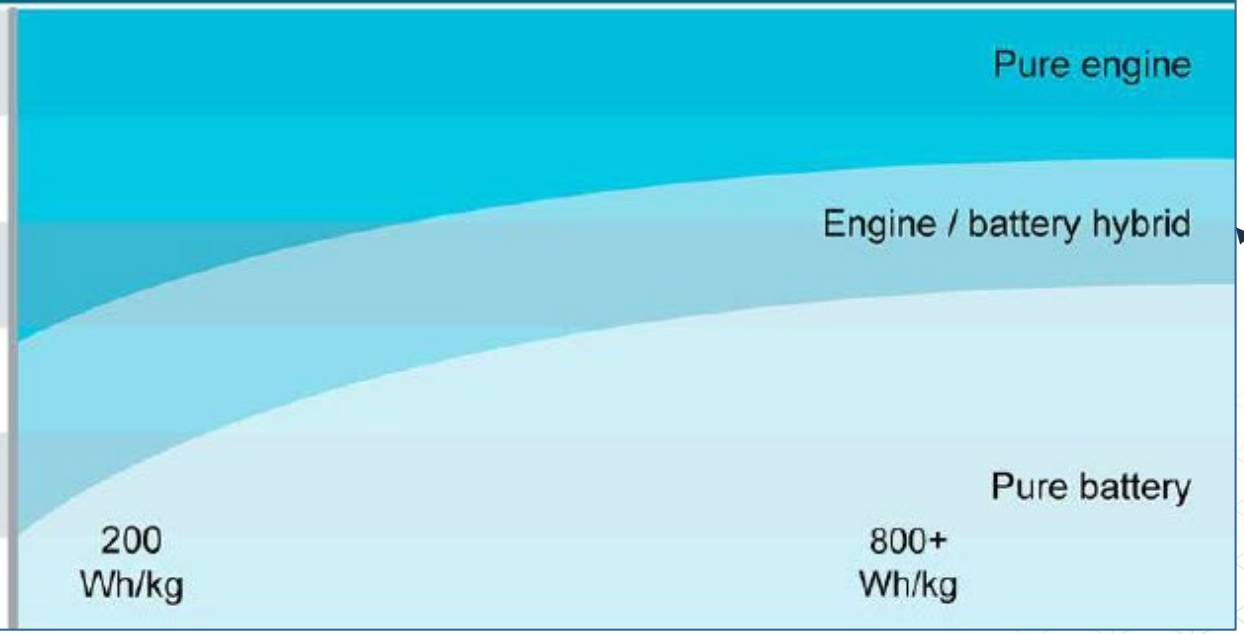
Even with 1000 Wh/kg batteries, an All-Electric Airbus A320 requires **170 T** of batteries, compared to **20T of fuel** today

→ Need breakthrough in technologies to increase density storage

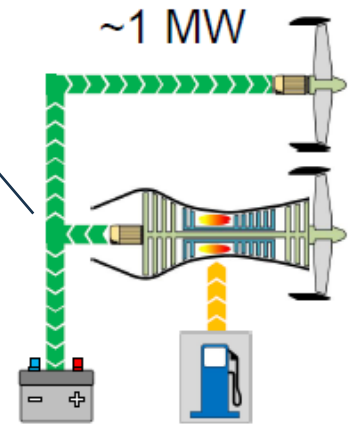
MTU Rolls-Royce SAFRAN

When will we have electric flight?

Vehicle	nm
Large widebody	4000
Middle of market	1500
Regional aircraft	500
Intra-city air taxi	200
GA aircraft	100
Intra-city air taxi	25



95% av allt flyg

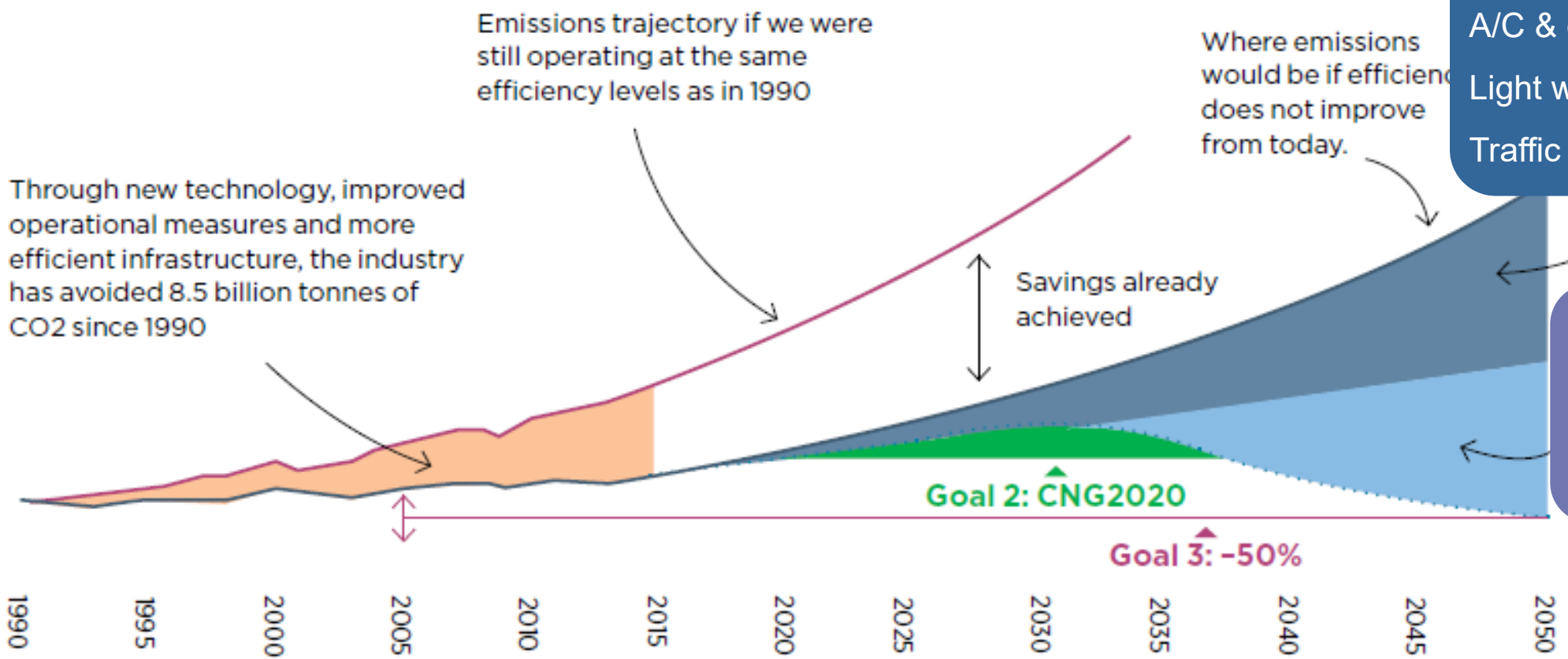


20% e-Propulsion

From RR, SAFRAN, MTU: Position paper towards Horizon Europe

Solutions relative to 1990 emissions with projected travel growth

Källa: ATAG



Innovation @ same pace:

A/C & engine efficiency

Light weight

Traffic management

Gradual introduction of sustainable fuels

Klippt ur:
***FÄRDPLAN FÖR FOSSILFRI KONKURRENSKRAFT** -Flygbranschen*

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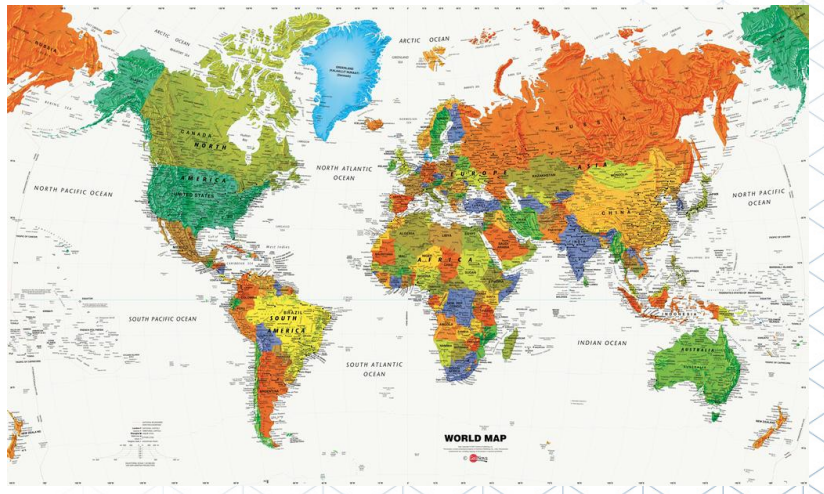
Varför flyger vi?

Affärsresor – (samhälle, politik, forskning)
Nöje – konsumtion
Transporter
Knyta ihop regioner



Globala strömningar
Välj det transportslag som är bäst lämpat
Globala regleringar krävs

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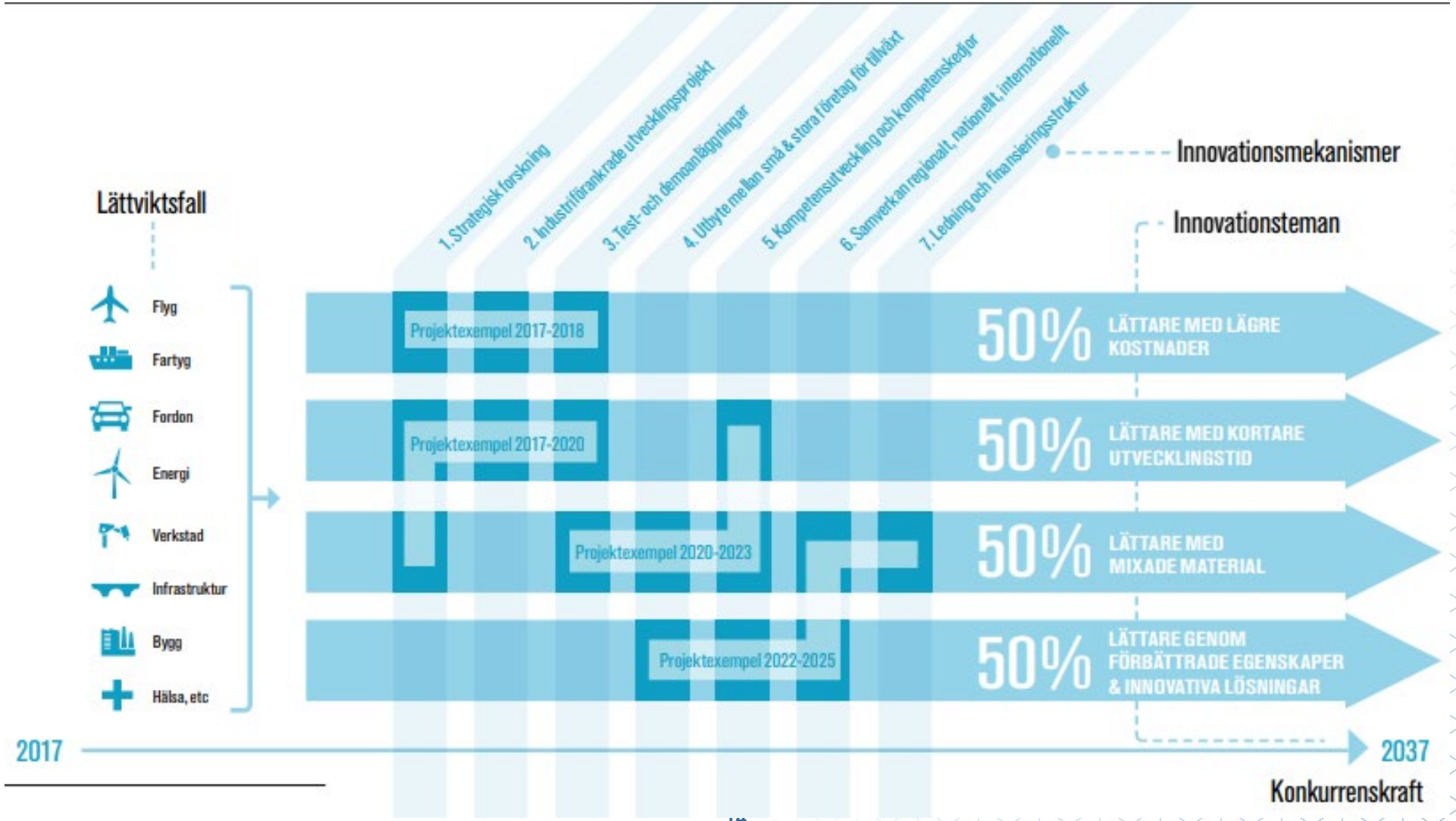
Examples along the four Innovation Themes in LIGHTer



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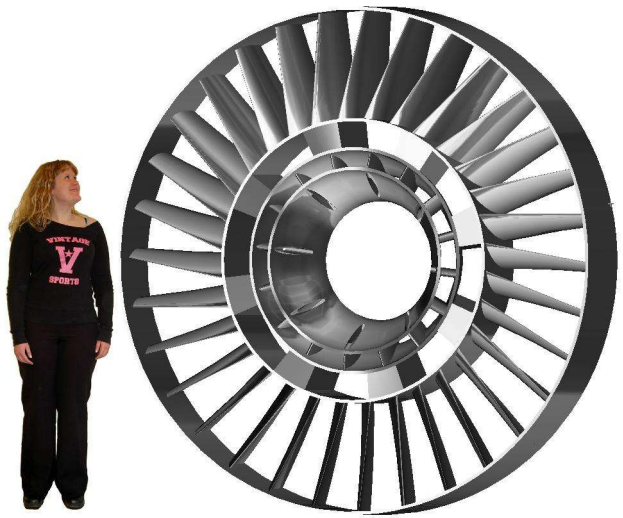
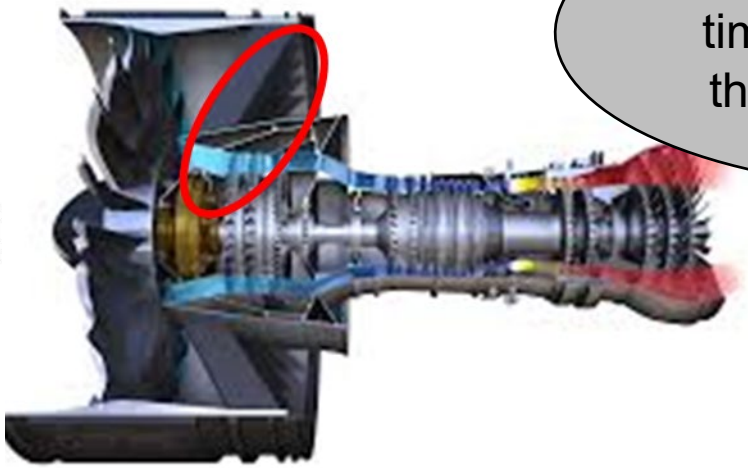
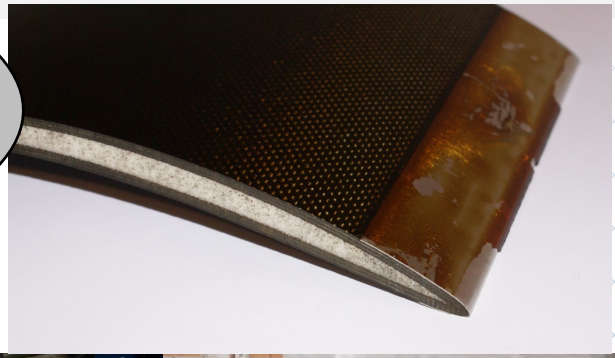
Cost… if the technology is too expensive it will not be applied

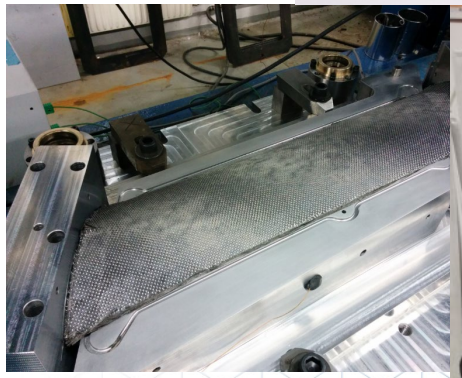




-”Typically composite engine parts are three times more expensive than metallic parts”… or not?



Robotoized pick, place and drape of ~100 pieces of reinforcment - replace manual lay-up



Introduction of light weight cores, co-curing of metallic leading edge, Co-bonding of metallic joints

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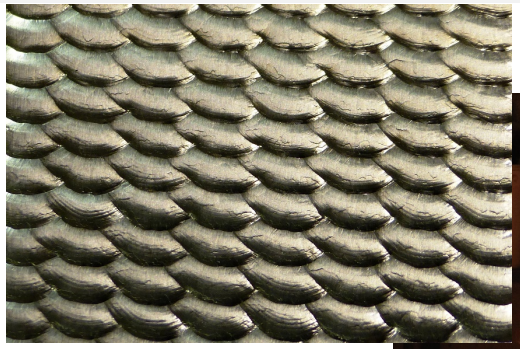
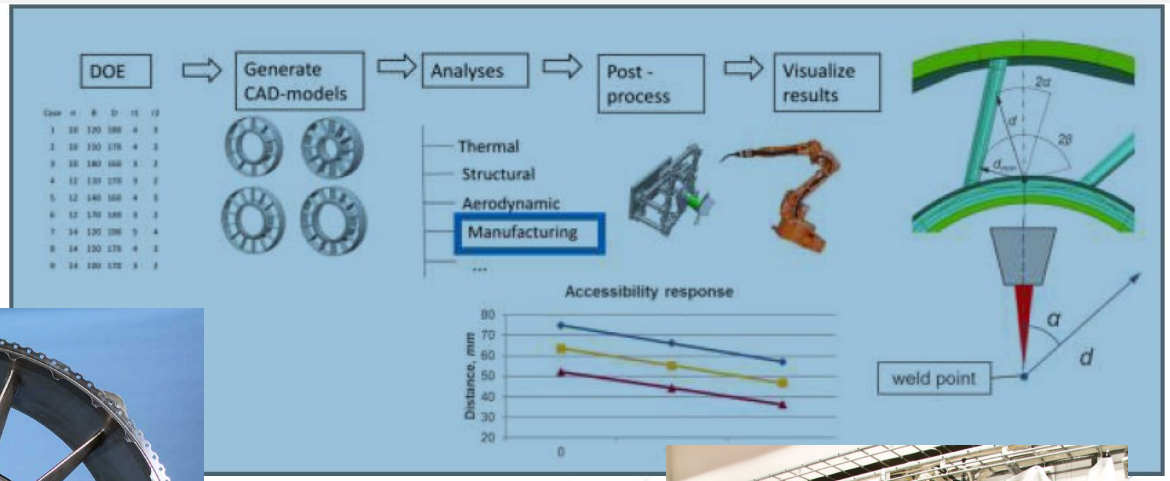
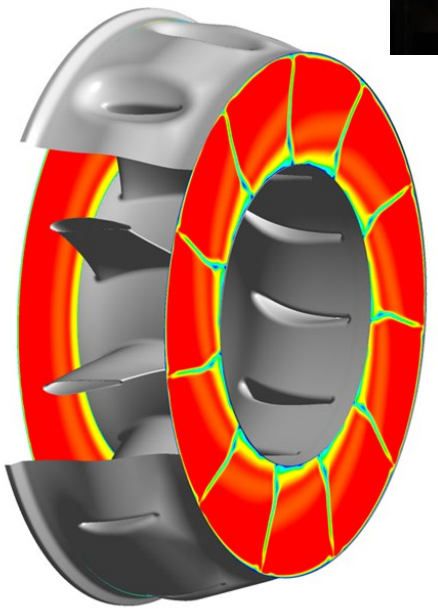
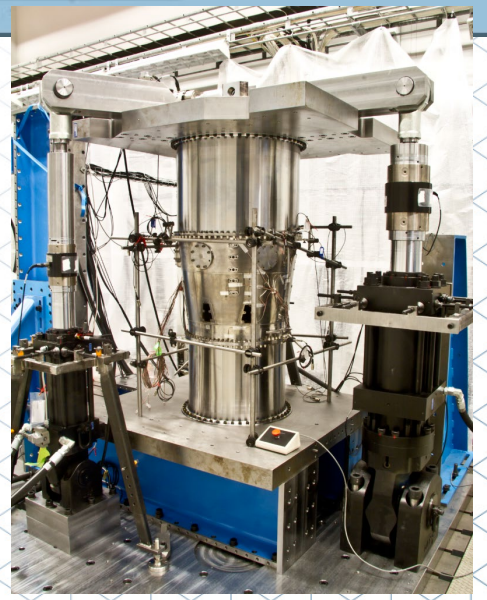
Engineering methods – optimization and doing things in time









Multi-discplinary Optimization

Solves for weight, cost and performance trade for hundreds of conditions

Material/Proecess selection, Aero performance, Tool accessibility, Structural aspects

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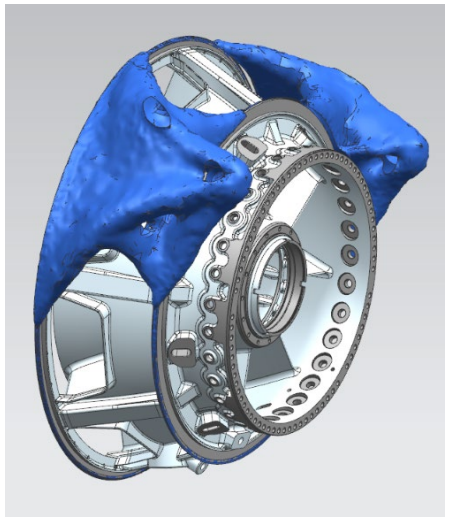
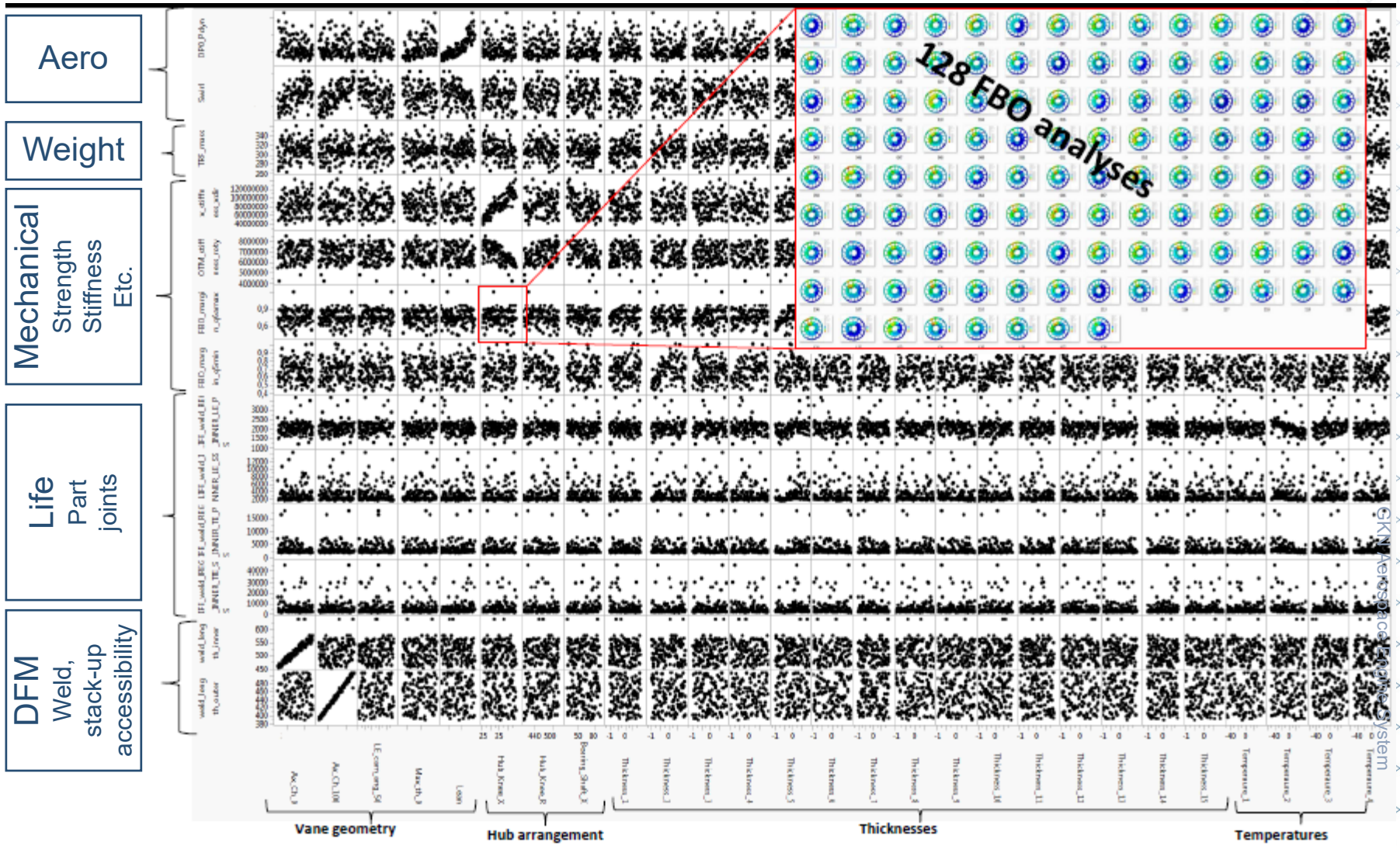
Illustrating multidisciplinary optimization

- Design Space Exploration
- enabled through design automation and big data analytics
- enabling functional trade offs

Advances in computer aided engineering support technology integration

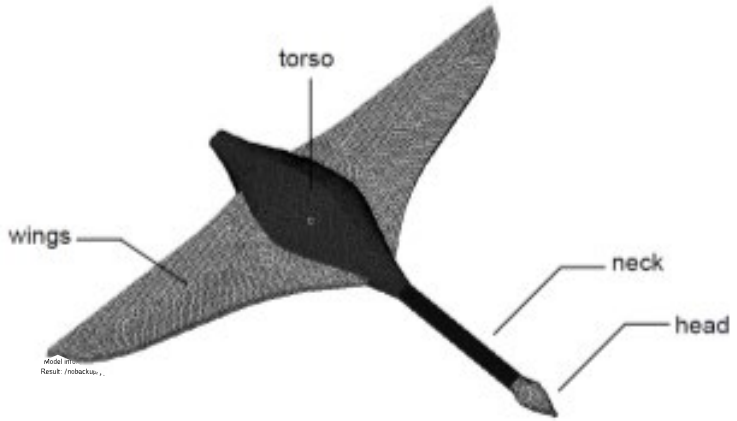


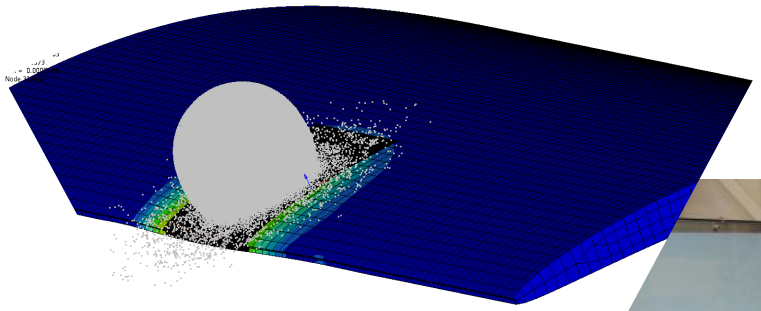
Topology opt.

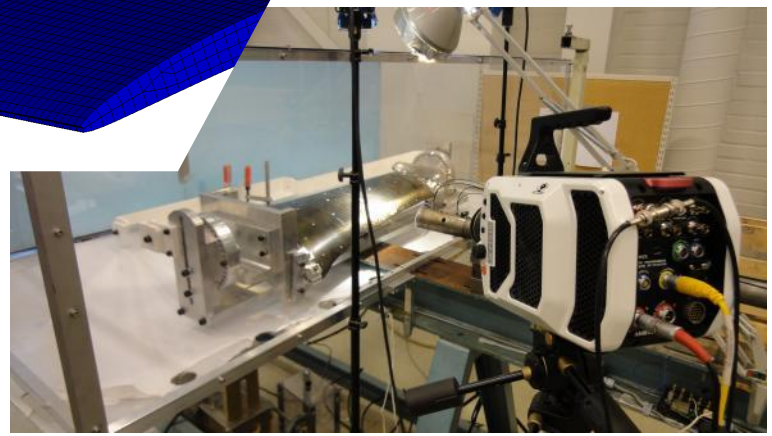


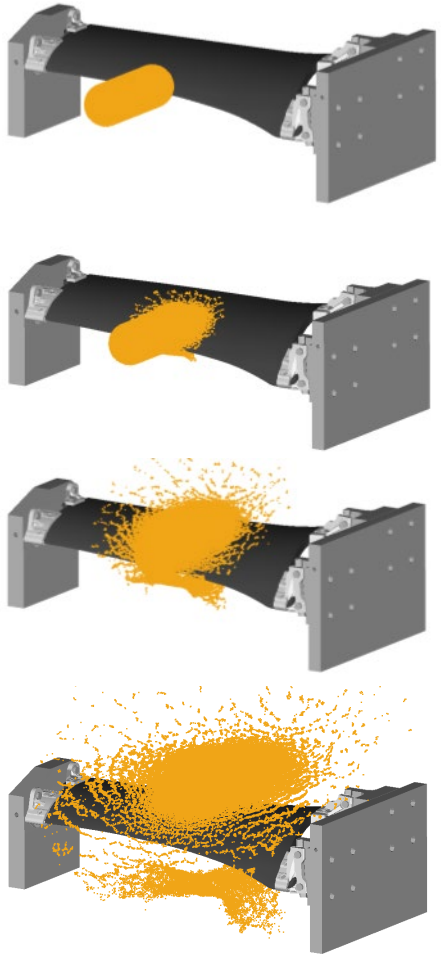
©GKN Aerospace Engineering System

And we are doing some other stuff..





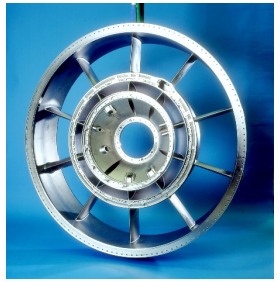




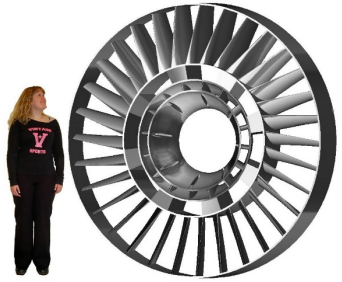
Geese size (250km/h)

50mm hail stone (550km/h)

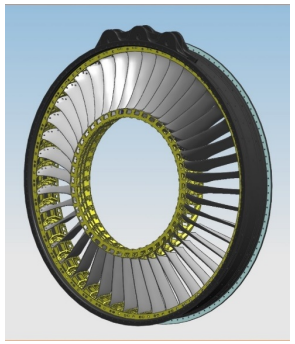
Using mixed materials to reduce weight and cost



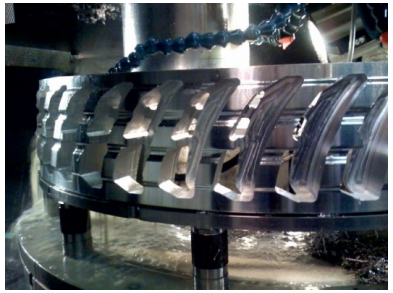
Nineties
Titanium



“SIRIUS” 2004..
“Paper concept”
600 pieces needed for assembly of mould tool.
30% weight reduction



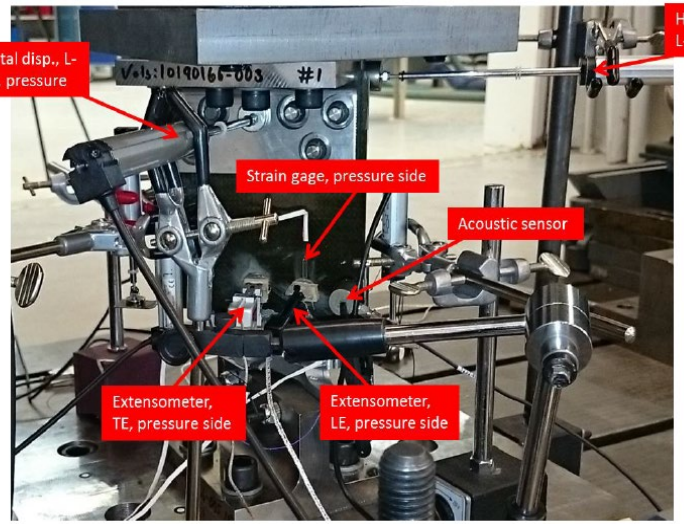
2005
Hybrid concept requring 18 pieces
Metallic T-joints for strength and maintenance

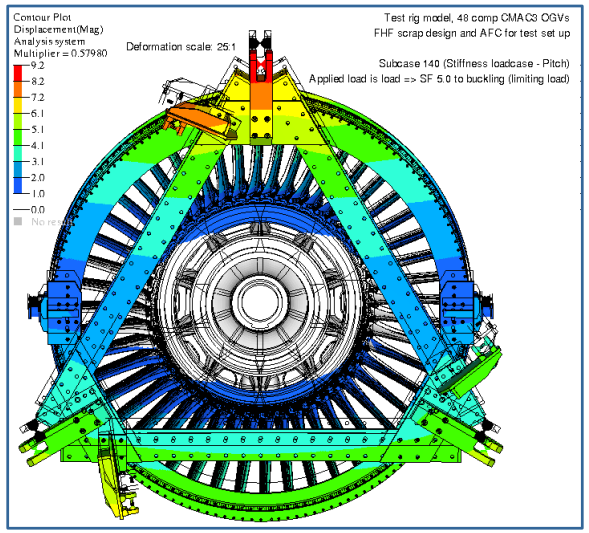


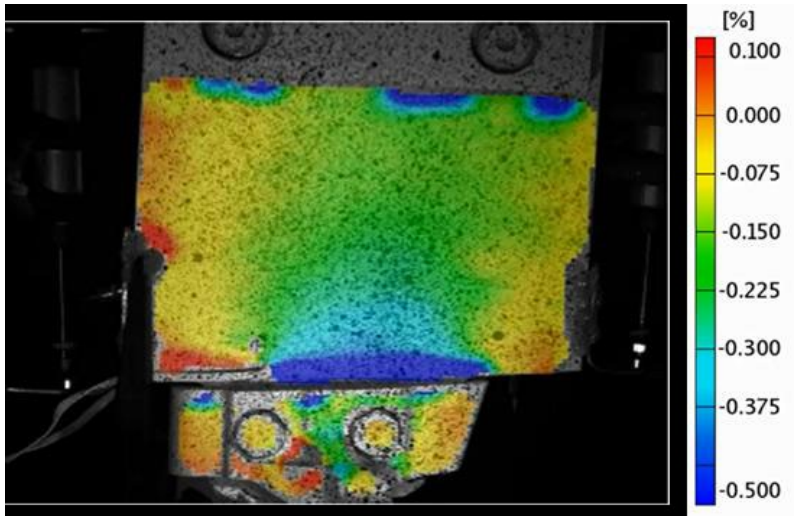
VITAL 2008
~20% weight reduction
Φ = 2m

2016
New joints
Light weight core introduced
“Sandwich”
Φ = 3m

Testing is necessary for proving the technologies

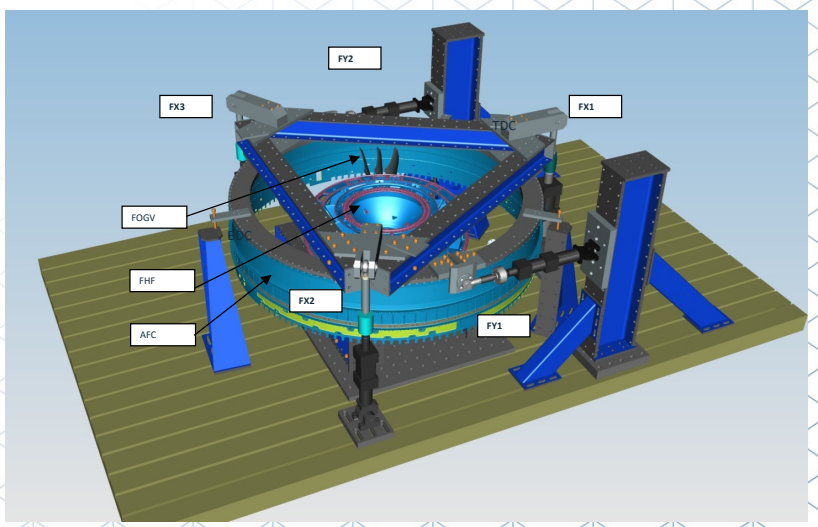






Left:
Joint sub-component test with opical straing measurments - @ RISE SICOMP.

Above and right;
¨Full scale stiffness and strength test at GKN



20

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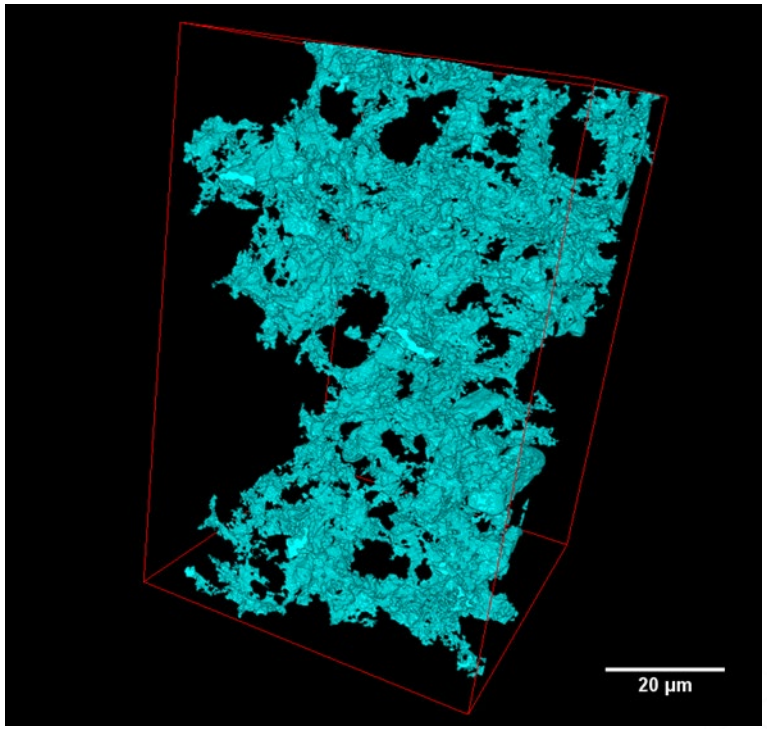
Improved properties – looking for better materials

MM/LF: High Entopy Alloys and ICME (Integrated Computational Materials Engineering) to find new chemistry for better alloys. (Jönköping University, Sandvik, Chalmers, Thermocal)

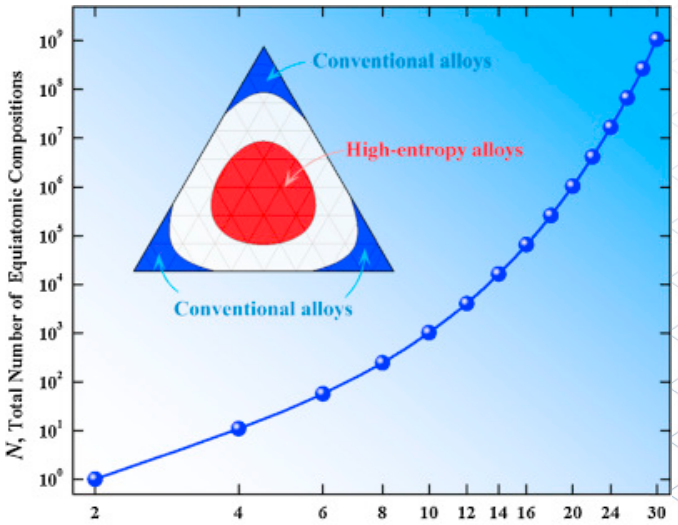
LF: Ultra-stiff and strong composites for structures with complex geometries? (Chalmers, OXEON, KTH)

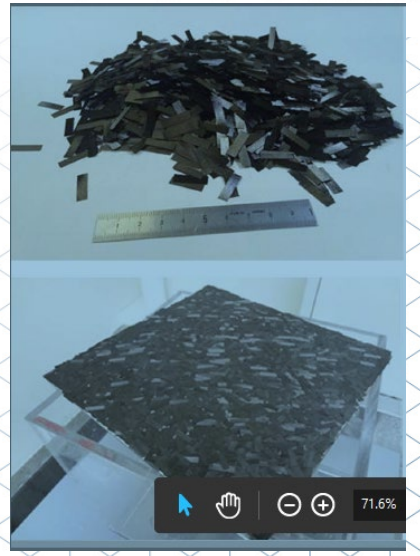
L/G: Graphene coating of composites (SICOMP, NEXAM, Woxna Graphite)

L: Aluminium with TiB2 microgrid (Jönköping University, SWECAST, FUNDO Components)



Measurements done by Professor Arne Dahle, JU at the syncrotron facility in Grenoble



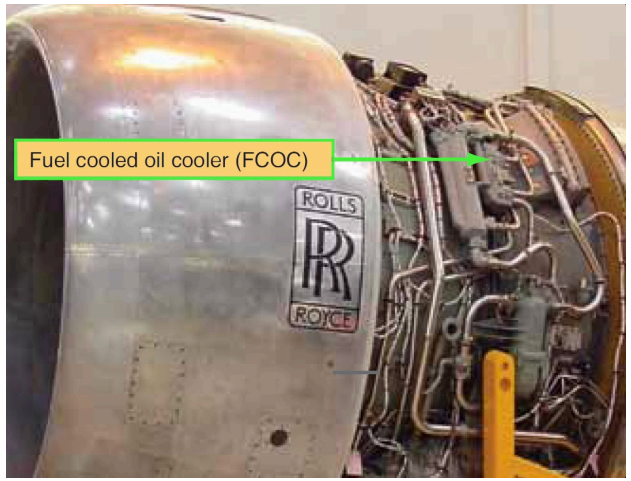


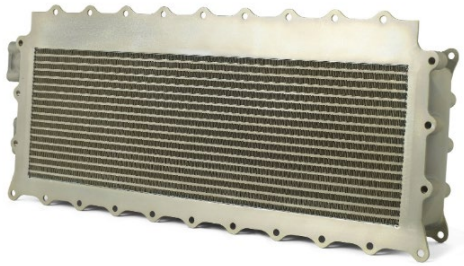
L: LIGHTer
MM: SIP Metalliska Material
LF: LIGHTer genomförbarhetsstudie
G: SIP Graphene

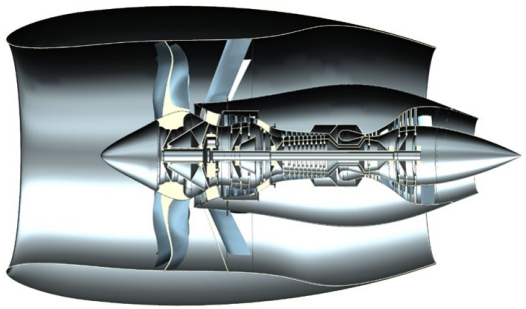
Document id], version [version number], Secrecy class [Secrecy class

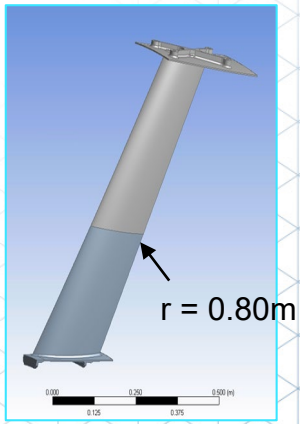
Weight saving by integrating functionality

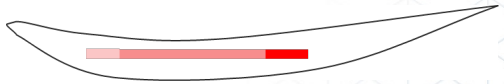
Replacing a separate gearbox oil cooler by integrating the cooler in aerodynamic vanes

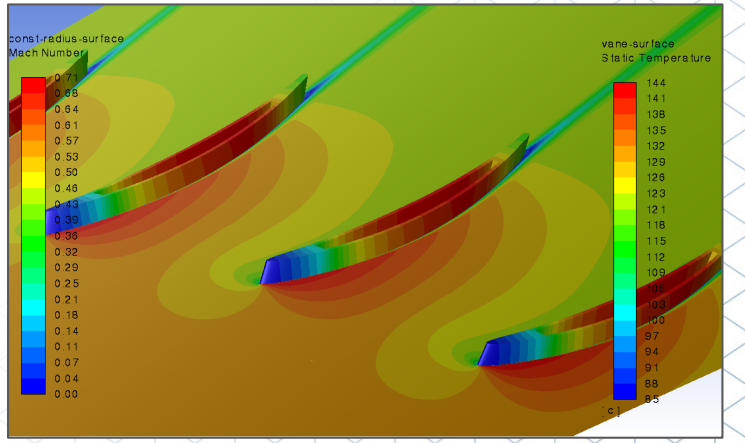












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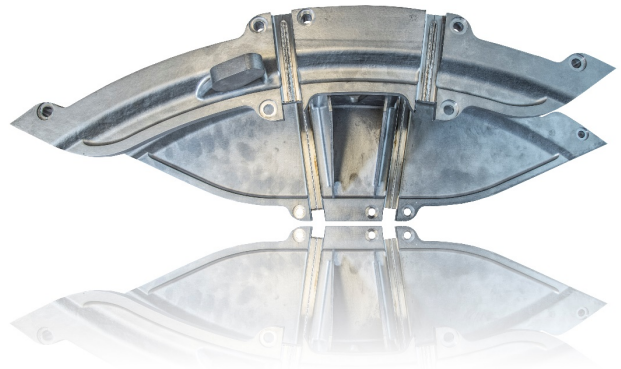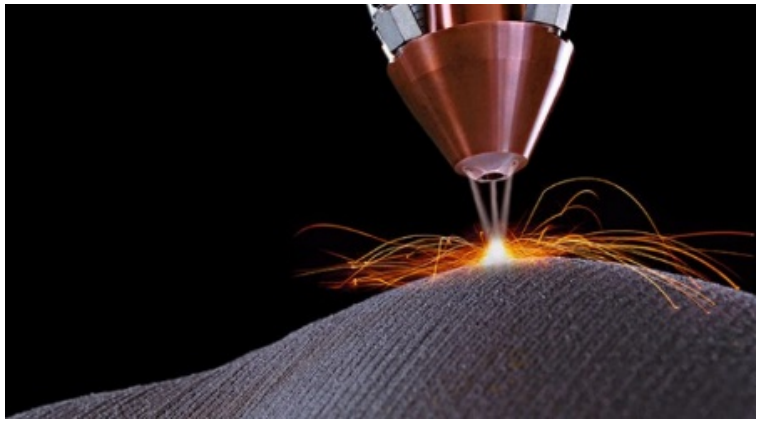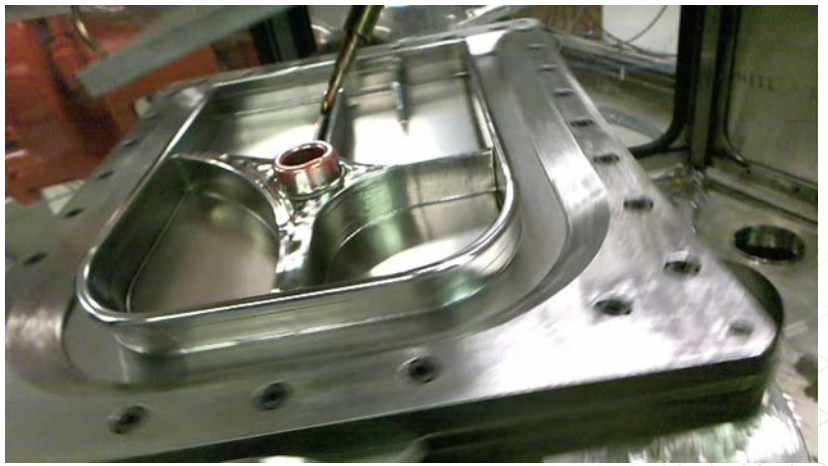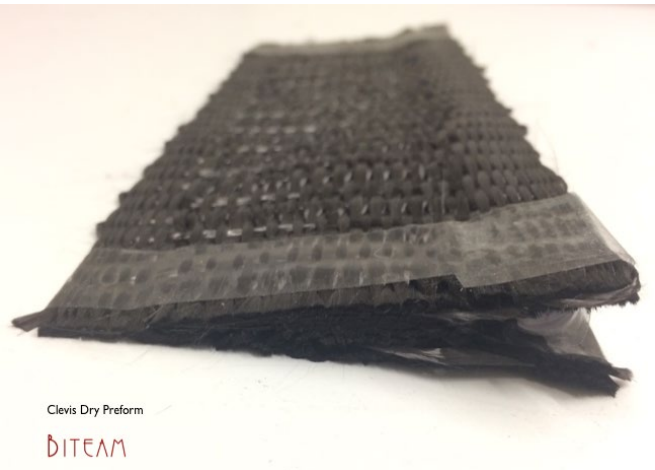
And I did not mention Additive Manufacturing☺,¨… and 3D weaving