

Open Rotor Technology  
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NASA Ames Research Center



Environmentally Responsible Aviation Project  
Subsonic Fixed Wing Project

Open Rotors are specialized high-speed propellers

They are very efficient propulsors

...the challenge is to make them quiet.



Overall  
Propulsion  
System  
Efficiency

=



Thermal  
Efficiency

X



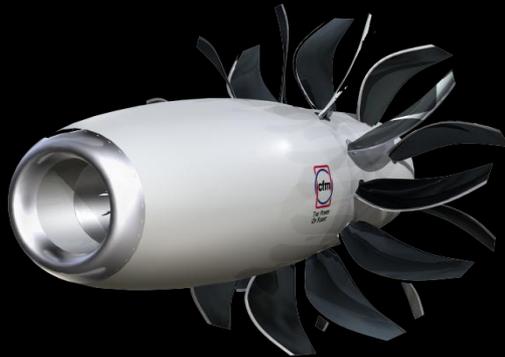
Propulsive  
Efficiency

X

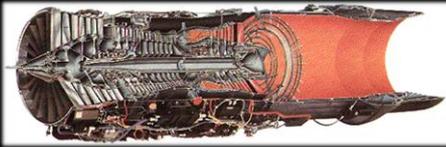


Transfer  
Efficiency

Ultra-high bypass systems have the potential to greatly increase propulsive efficiency



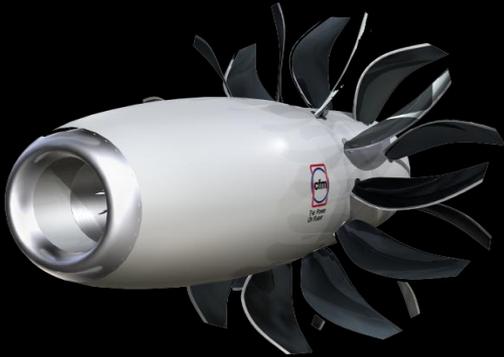
$$\text{Thrust} = \text{Mass of Air} \times \text{Change in velocity}$$



AIR



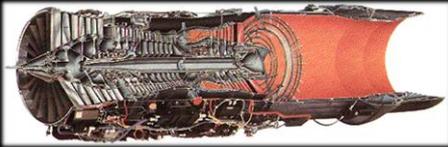
Increasing Propulsive Efficiency



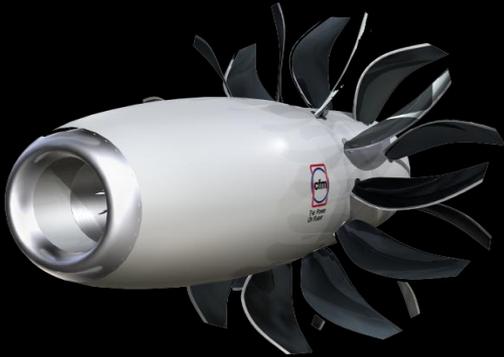
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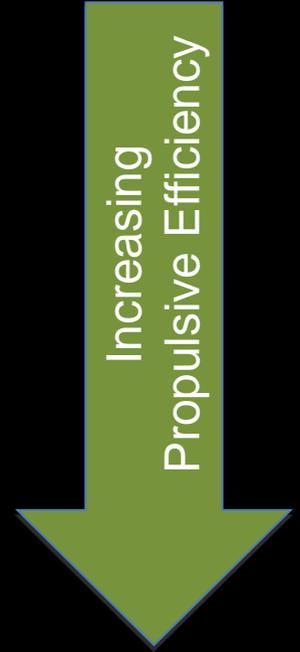
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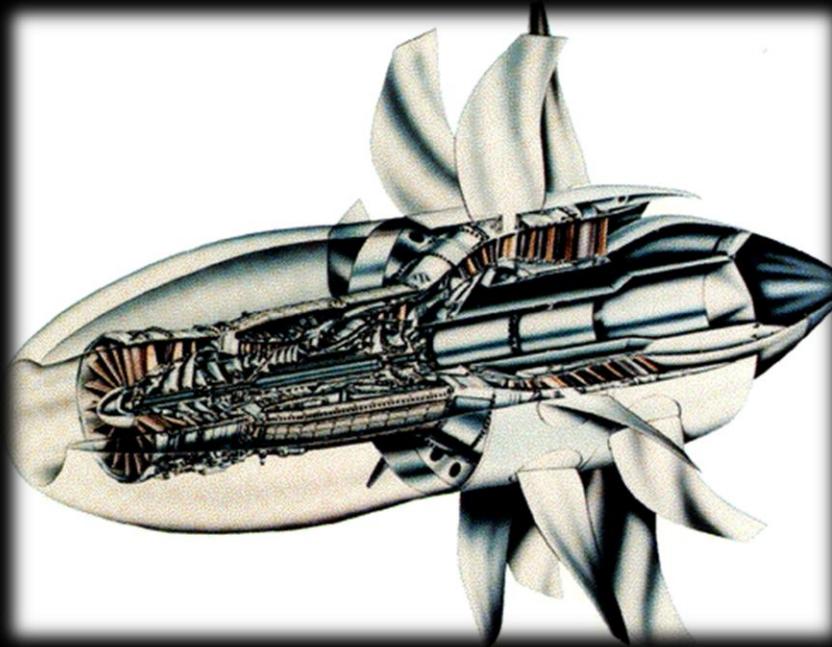
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AIR



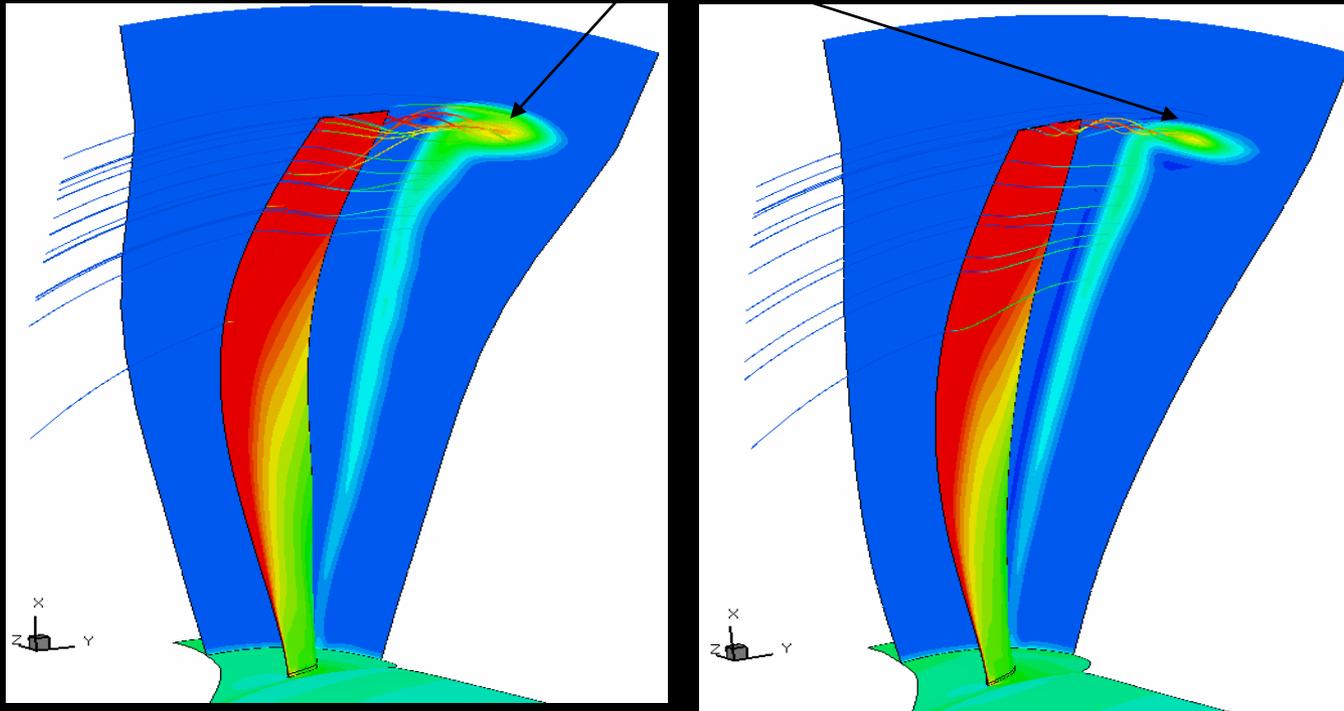
One method of going to ultra-high bypass ratios is to ...



GE UDF

... remove the nacelle.

## Tip vortex



State of the art flow simulations are being used to modify the open rotor tip vortex at take-off conditions to reduce the noise generated. (image courtesy of GE)



NASA is testing new Open Rotor designs in collaboration with GE Aviation and CFM.

## Advanced diagnostics measurements ...



... such as acoustic phased array.

## Challenges:

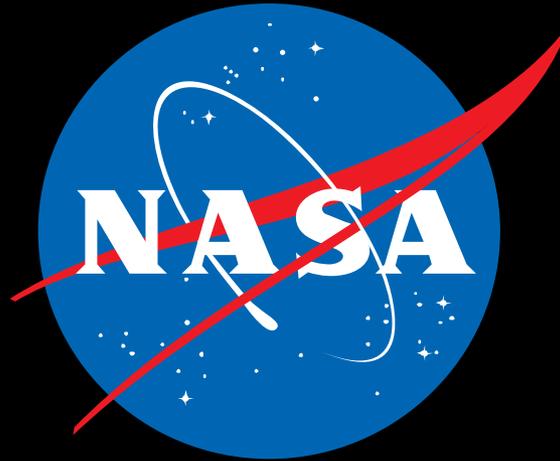
- Installation Effects
- Flight Certification



UDF on B727

Preliminary analysis of the data shows progress has been made over 1980's era designs. Modern designs have demonstrated noise reduction while maintaining efficiency.





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