

Vari-Speed II

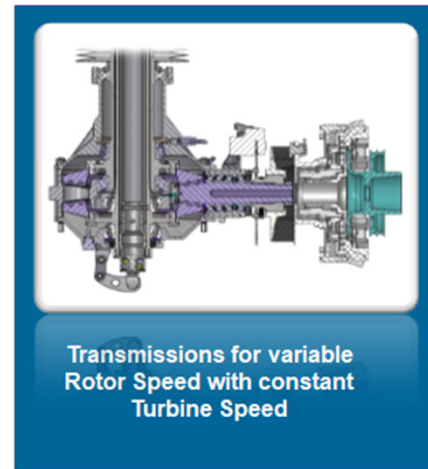
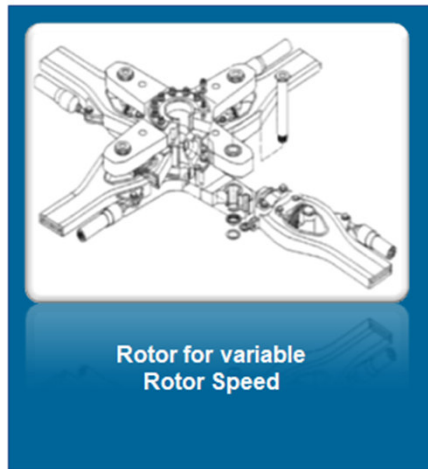
Variable Rotor Speed for High-Speed Helicopters and Tiltrotor-/Tiltwing Aircraft

Michael Weigand
TU Wien – Research Unit Machine Elements and Transmissions for Aviation
Vienna, Nov. 12th, 2025

Brief description of the consortium partners

- Technical University Munich,
Institute for Rotorcraft and Vertical Flight (Germany)
- Zoerkler GmbH, Jois (Austria)
- ADT Engineering (Vienna, Austria)
- Technical University Wien (Vienna, Austria):
 - Research Unit of Fluid Flow Machinery
 - Research Unit of Control and Process Automation
 - Research Unit Transmissions for Aviation

Brief description of the consortium partners



Aim of the project / Background of the project

- Realisation of variable rotor speed with constant turbine speed for high-speed helicopters (e.g. **RACER** – **R**apid and **C**ost **E**ffective **R**otorcraft by Airbus Helicopters) and tiltrotor-/tiltwing aircraft (e.g. **NGCTR** - **N**ext **G**eneration **C**ivil **T**iltrotor by Leonardo). This implies a gearbox with the possibility to vary the gearbox ratio during flight. Furthermore a rotor is needed that can be operated with variable speed
- Reduction of turbine speed to reduce rotor speed is – with high efficiency – only possible in a small speed range. This speed range is too small.

Aim of the project / Background of the project



RACER



NGCTR

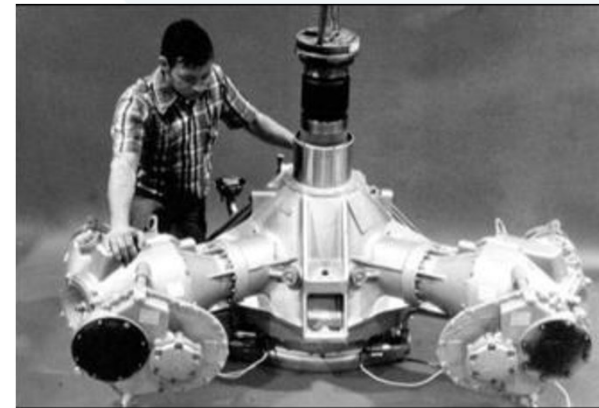
Project results

- After investigation of the feasibility of variable rotor speed in Vari-Speed in Vari-Speed II the whole drivetrain from turbine to rotorblade was developed and the behaviour of each component and the whole system was investigated in dynamic simulations. The helicopter Black Hawk UH_60A was used as reference.
- Besides the simulations a test campaign was conducted in the helicopter simulator at TU Munich with active pilots to get their feedback.

Project results

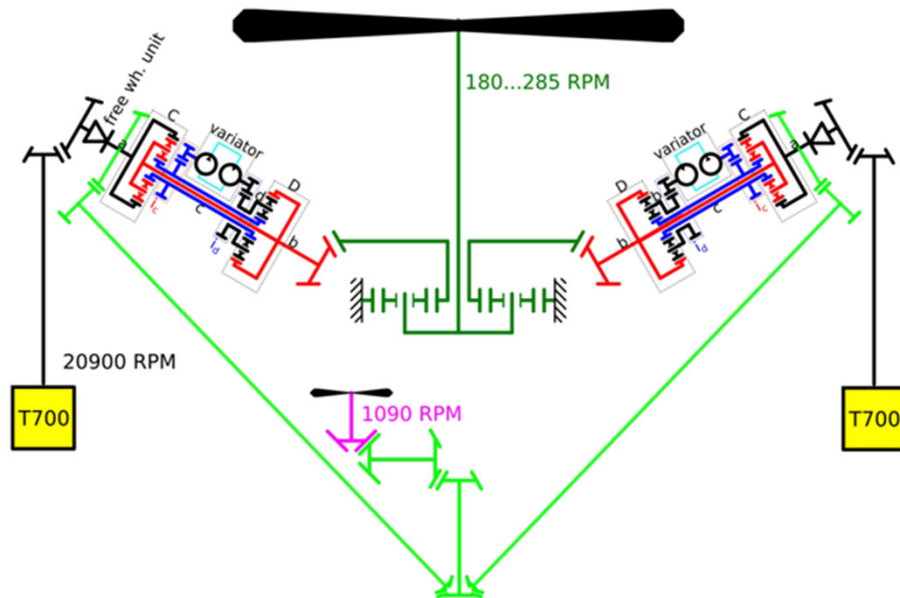


Sikorsky Blackhawk



MGB – Main Gearbox

Project results



Main Gearbox with
Compound Split
for variable ratio

Project results

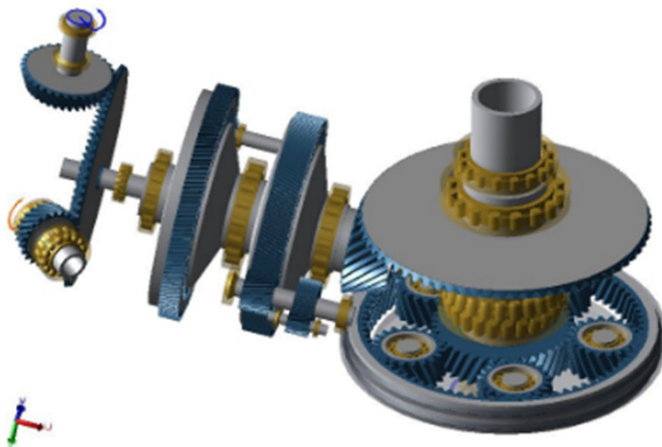


Figure 8: Model of the transmission system, modelled within FVA-Workbench® (only one turbine input and Compound Split visible).

Project results

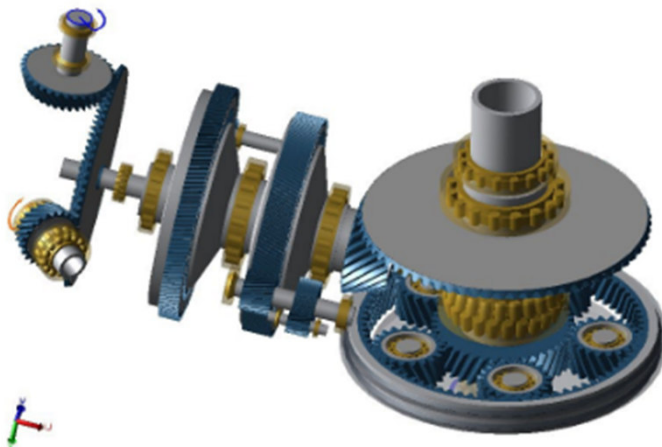


Figure 8: Model of the transmission system, modelled within FVA-Workbench® (only one turbine input and Compound Split visible).

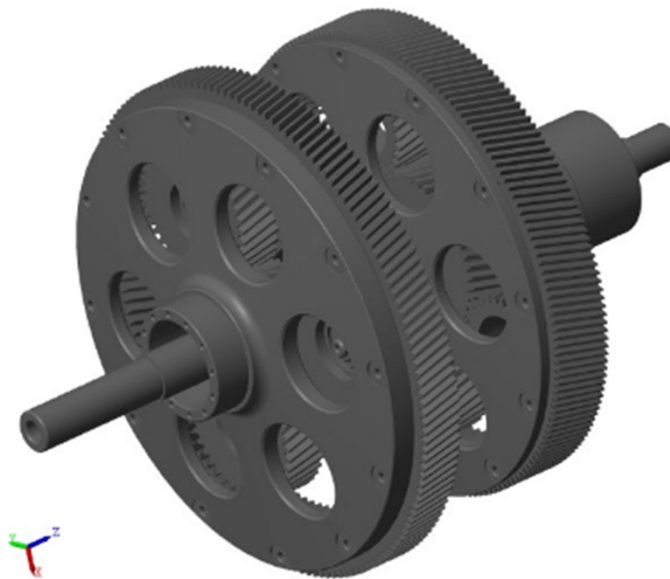
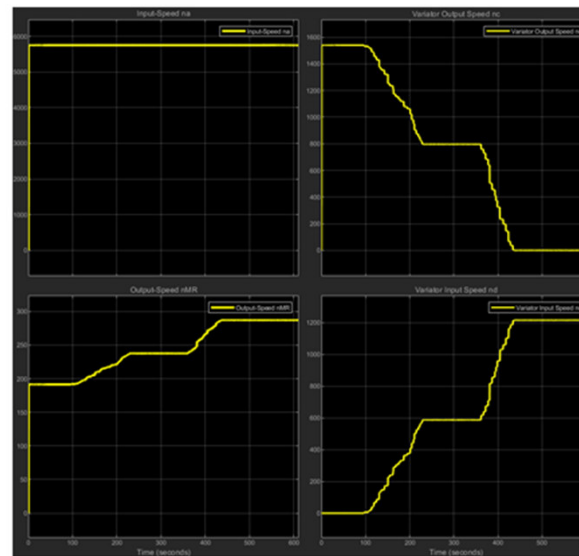


Figure 10: Model of the Compound Split, modelled with Matlab-Simulink®.

Project results

input speed

output speed



Variator
output speed


Variator
input speed

MP = Mechanical point

MP 1

MP 2 MP1

MP 2

 Federal Ministry
Innovation, Mobility
and Infrastructure
Republic of Austria



bmimi.gv.at

Project results



Simulator at TU Munich for flight test campaign

Utilization of the project

- Both European OEM's – Airbus Helicopters and Leonardo support the idea of variable speed
- Vari-Speed was presented several times at the Forum of the Vertical Flight Society (VFS) in the USA and found interest especially from Boeing. Vari-Speed is applicable for e.g. the Bell Valor V-280 and Sikorsky/Boeing SB-1 Defiant developed in the Future Vertical Lift Program (FVL)

Utilization of the project



Bell V-280



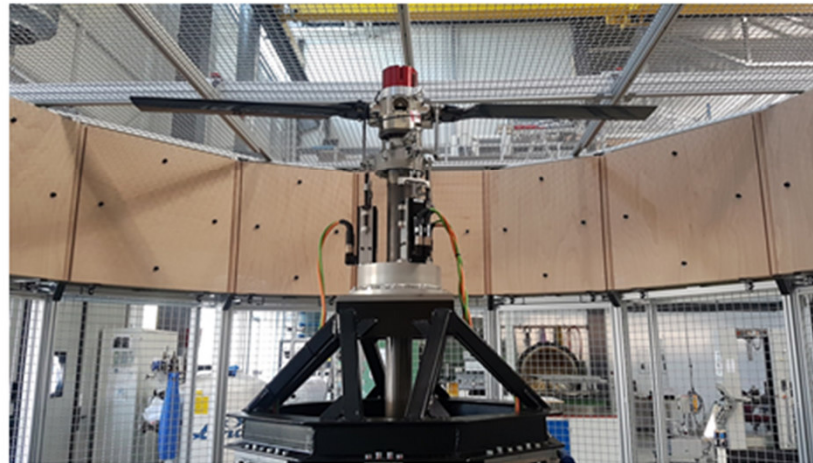
Sikorsky-Boeing SB-1 Defiant

Further steps/(potential) follow-up projects

- Next intended steps are the testing of subscale models of the compound split system as well of the rotorhead
- On European level integration studies in RACER and NGCTR could be reasonable next steps
- Potential further steps are tests in the LRTA (Large Rotorcraft Test Apparatus) at NASA Ames and finally flight tests

Further steps/(potential) follow-up projects

- (Scaled) models and testing of components



Further steps/(potential) follow-up projects

- Testing of the system

