A Computational Tool for Rotor Design

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Helicopter and tilt-rotor blades produce complex vortical flow fields that interact with the nacelles, wings, fuselage, and the ground. Rotorcraft designers need an efficient computational tool that can model these vortical flow fields and accurately predict the aerodynamic performance of rotary-wing vehicles. The purpose of this project is to develop a computational tool with which to model the complex flow fields around rotors and bodies. In an industry design environment, turnaround time must be reduced to a level at which design cycles can be conducted within schedule and cost. Therefore, the computational tool must be efficient and easy to use.

With Ames' funding, Sukra Helitek Inc. developed a software tool called Rot3DC, which simulates the flow field around rotary-wing vehicles. The method employs a graphical user interface to model either isolated rotors or rotor and fuselage problems, including ground interference. Rot3DC solves the Navier-Stokes equations on unstructured grids with a simple, but effective, momentum-source representation for the rotor blades. This momentum-source rotor-blade model allows for highly efficient solutions of rotor flow fields.

Figure 1 shows a sample aerodynamic solution from the Rot3DC code for a V-22 tilt-rotor landing on the deck of an aircraft carrier. This figure demonstrates the complicated interactions between the rotor downwash, the wings of the V-22, and the deck of the ship. Despite these complex flow-field features, the Rot3DC code can model these solutions in a matter of hours on a high-end personal computer. This rapid turnaround and simplified problem setup make Rot3DC well-suited for helicopter design applications. Indeed, the Boeing Company has licensed Rot3DC and is using it to model the Comanche helicopter and V-22 tilt rotor.

Sukra Helitek Inc. plans to upgrade the Rot3DC computer code to include a higher-fidelity unsteady rotor model and solution-adaptive grids for improved modeling of rotor wakes. These modifications should improve the overall analytical accuracy while retaining the ease of use and rapid turnaround of the original Rot3DC software package.

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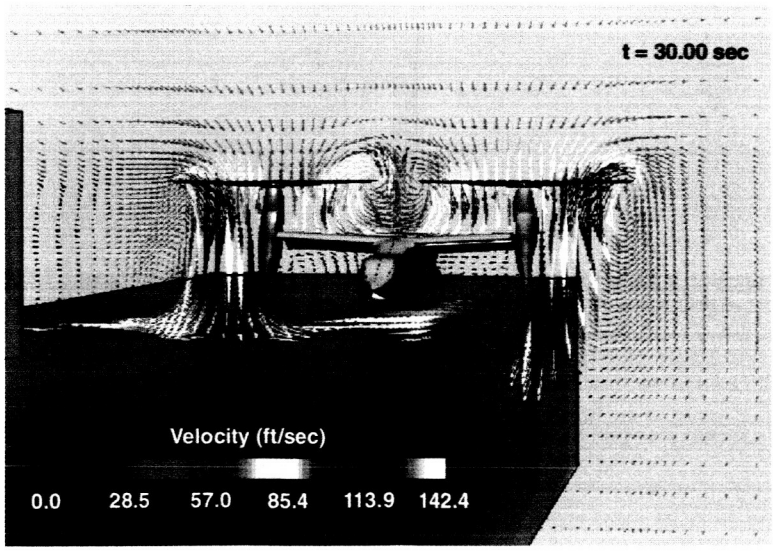

Fig. 1. Computed velocity flow field for the V-22 tilt rotor during a shipboard landing.