

The Dayton Engineer

PROFESSIONAL BOOK REVIEW: PLANETARY EXPLORATION WITH INGENUITY AND DRAGONFLY: ROTARY_WING FLIGHT ON MARS AND TITAN, by RALPH D. LORENZ

This book outlines the basics of rotary wing flight these distinct endeavors and their intersections, and explains the design goals of Ingenuity and Dragonfly.

Rotary-Wing Flight

Helicopters are controlled by varying the rotary blade pitch as a function of the angle of the blade around the rotary circle.

A. Design of the Mars helicopter Ingenuity

Mars environment: The Martian atmosphere consists mainly of low-density carbon dioxide.

The Ingenuity rotors are made of carbon fiber. Carbon fibers were chosen to limit out-gassing that might contaminate samples that might be collected. The Mach number of the rotor tips limits the rotor span and rotation rate. This avoids the shock waves that would be produced if the rotor tips should be supersonic.

Power and thermal systems: Electrical power is produced by solar cells. Dust on the solar cells can limit the power output. The flight time of Ingenuity is limited by motor heating. The low atmospheric density limits convective cooling.

The Ingenuity helicopter and the Perseverance rover were delivered by parachute NASA's 2020 Mars mission in 2021. On April 19 of that year, Ingenuity became the first aircraft to complete a powered, controlled flight on another planet. (Electrical power for the Perseverance rover is produced by plutonium dioxide fueled thermoelectric generator.)

B. Dragonfly is a helicopter that is planned for operation of Saturn's moon Titan

Dragonfly is a rotorcraft that is much larger the Ingenuity. It is currently scheduled to launch in 2027 and arrive on Titan by 2034. Dragonfly is expected to fly many kilometers in each of dozens of flights.

Dragonfly concept:

Dragonfly is planned to be multi-rotor, relocatable lander roughly the size of Perseverance. Dragonfly is intended to explore dozens of sites across Titan's diverse landscape and access surface materials of interest for prebiotic chemistry. Electrical power for Dragonfly is planned to be produced by a plutonium dioxide fueled thermoelectric generator.

Titan environment

Titan has a thick atmosphere of nitrogen and methane, oceans of methane and ethane, an ice crust, and an internal water ocean.

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PROFESSIONAL BOOK REVIEW: Planetary Exploration with Ingenuity and Dragonfly (Cont.)

RALPH D. LORENZ is a planetary scientist at the Johns Hopkins Applied Physics Lab. His research focuses on understanding how systems and instruments work in planetary environments, and on exploring surfaces, atmospheres, and their interactions, on Titan, Venus, Earth and Mars. He is the Mission Architect of Dragonfly, NASA's New Frontiers mission to Titan, and is involved in many NASA and international planetary missions including Cassini/Huygens, Akatsuki, Insight, Perseverance and DAVINCI. He is the recipient of the 2020 International Planetary Probe Workshop (IPPW) Al Seiff memorial award. He is the author or co-author of numerous publications, including Saturn's Moon Titan: Owners' Workshop Manual (2020), Spinning Flight (2006), Space Systems Failures (2005), and Planetary Landers and Entry Probes (2007). He holds a B.Eng. in Aerospace Systems Engineering from Southampton University and a Ph.D. in Space Sciences from University of Kent.

This book is available at the American Institute of Aeronautics and Astronautics web site: AIAA.org.

PROFESSIONAL BOOK REVIEW BY DR. RICHARD HENRY, PE, PHD, DSPE PAST PRESIDENT

DSPE/OSPE/EFO Calendar

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| 13-16 May | National MATHCOUNTS Competition |
| 8 Jun | DSPE Monthly Meeting, 12:00 Noon, Dayton Engineers Club, Ohio Concrete |
| 8-9 Jun | All Ohio Engineer Conference, Virtual Presentations |
| 10 Jun | All Ohio Engineer Conference, In-Person annual meetings |
| 13 Jun | DSPE Board Meeting, 5:15 PM, CHIME Format |
| 11 Jul | Mark the Date, DSPE Officer/Director Installation, Location TBD |
| 13 Jul | DSPE Monthly Meeting, 12:00 Noon, Dayton Engineers Club, Pretek Group, Texas Twin Leaf Precast Concrete Arch Bridge |
| 10 Aug | DSPE Monthly Meeting, 12:00 Noon, Dayton Engineers Club, Ohio Concrete |
| 12 Sep | DSPE Board Meeting, 5:15 PM, CHIME Format |
| 14 Sep | DSPE Monthly Meeting, 12:00 Noon, Dayton Engineers Club, Annual Legislative Update |