

**Virtual Autonomous Fast-Time Exploration of Large Domains of Complex/
Unknown Flight Situations for Safety through Lifecycle:
Present, Future, Benefits and Pitfalls**

(presentation abstract)

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Virtual flight testing and certification (VFTC) technology has a proven track record of successful validations and applications for a number of aircraft types and design projects. The goal of VFTC process is to predict branching dynamics of the 'pilot/ automaton - aircraft - operating environment' system and evaluate the system's safety performance in complex (multifactor, off-nominal, critical, hazardous, anomalous) or unknown flight situations - before an aircraft is built/flown. The technology's exploratory power is due to the synergy of high-fidelity mathematical modeling, fast-time simulation, situational control, artificial intelligence, knowledge mining and mapping, and some other techniques.

VFTC is thought to become a 'bridge' between a vast library of potentially unsafe complex/ unknown flight situations (baseline scenarios exacerbated by the presence of several risk factors) and latest achievements in computing and information technology. Baseline scenarios are derived from airworthiness regulations, test programs, standard operating procedures (e.g. AC120-71A/B), training syllabuses, accident/ incident reports, pilot's manuals, or flight operation/simulator data records. Risk factors include pilot errors/inaction/inattention, onboard hardware failures, automatic control logic/data errors, adverse weather conditions, and design/equipment options.

The outcome is a tree-type database incorporating thousands of complex flight situations ('what-if' cases) built around each baseline scenario, and a collection of 'a bird's eye view' knowledge maps representing the system dynamics and safety performance - for qualitative/quantitative analysis and knowledge synthesis. The following categories of specialists can benefit from VFTC through lifecycle: designer (aerodynamics, flight control, powerplant), test engineer/ pilot, regulator, instructor/ student, line pilot, safety engineer, investigator, and scientist.

As an innovative flight research method, VFTC is characterized by the challenges, successes and pitfalls of growth. In this presentation, an overview of the technology's current and future capabilities is given, including prospective off-board and onboard applications. VFTC benefits are summarized for main user categories. Advantages and limitations of the developed solution approach are discussed in comparison with other flight research methods.