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Design of Enhanced Methods for Aircraft Fuselage Inspection

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Abstract: Advances in robotics and imaging technologies show potential to reduce costs, time and to improve quality of the aircraft fuselage inspection process. This can be achieved by combining non-contact imaging technology (e.g. synthetic aperture imaging, laser-ultrasonic) with alternate delivery methods (e.g. robotic crawlers and robotic arms). Results of a stochastic simulation of the inspection process for ten representative regions of the fuselage showed a decrease in inspection time with an increase in crack detection by the use of emerging non-destructive inspection technologies: laser-ultrasonic (average savings of 43.28 minutes per section), synthetic aperture imaging (average savings of 45.60 minutes per section), and thermographic robotic crawler (crack detection rate increase of 54% with an average increase of 26.86 minutes per section). A utility analysis focused on performance, safety, and ability to implement, the most viable technological alternatives rank: (1) non-contact laser-ultrasonic (0.824),(2) human inspector (0.811), non-contact synthetic aperture imaging (0.783), and thermographic robotic crawler (0.748). Non-contact laser-ultrasonic imaging has the current advantage due to the technology readiness level and detection abilities of sub-surface deviations. A business case model of five different sized maintenance facilities, ranging from 25 to 126 inspections per year, was analyzed to evaluate economy of scale for break-even points ranging from 3 to 0.5 years, and a return on investment for a five-year period, with an average annual ROI ranging from 35% to 182%, respectively.

Keywords: Aircraft Fuselage Inspection, Airworthiness, Commercial Aircraft, Eddy Current, Laser-Ultrasonic, Maintenance, Non Destructive Inspection, Synthetic Aperture Imaging Device.