When You Assume, You Make an *Ass* out of *U* and *Me*….

by Frank L. Frisbie and Suzette Matthews[1]

Imbedded within the seemingly endless—40 years' worth of—debate about how best to modernize the Nation's airspace and air traffic system are some underlying assumptions that no one seems willing to challenge. On closer examination, some of these maxims appear questionable, or to have no real basis in science or reason. Many impede progress, most result in additional cost to the taxpayer, many are unfair to some class or classes of operators, and some, if carried to their logical conclusion, might even introduce danger into the NAS. Rather than simply accept these maxims as givens, each should be challenged and evaluated thoroughly in context whenever stated, and jettisoned if unwarranted. Here are some contrary viewpoints and data that can be used to test the validity of some of these common assumptions:

- ***Humans cannot safely be automated out of ATC.*** To the contrary, conversion to NAS systemwide automated 4DT in ATC could *enhance* safety. Human performance—in any enterprise, not just ATC—is fraught with dangers. Our senses, cognition and reasoning are limited and fallible, especially as tasks increase in volume and complexity, in the face of distractions, and as complacency or fatigue sets in. These limitations apply not only to direct operation, but to humans as monitors and regulators of automation. On the other hand, without the potential errors associated with human cognition and memory, advanced NextGen 4DT software would identify potential airspace conflicts, and deconflict those aircraft trajectories with mathematical certainty.[2] But despite previous suppositions, humans are incapable of performing the rapid, sophisticated, high volume computations characteristic of 4DT, and would likely be unable to assume operations in a failure situation. This probably will make it impossible for 4DT automation to default to human operation on any level[3] and still meet the requirements of an acceptable level of safety, as discussed below.

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[2]In advanced-state NextGen, today's air traffic controllers, or flight crews without the assistance of controllers, would become "Separation Managers." Their role would be to "Eliminate residual conflicts [from other aircraft and special use airspace] left by the three strategic functions of TBO. *Automation detects the conflicts and provides the resolution.*" [emphasis added.] *See* Concept of Operations for the Next Generation Air Transportation System, Joint Planning and Development Office, Version 3.2 (2011), https://apps.dtic.mil/dtic/tr/fulltext/u2/a535795.pdf , p. 2-33.

[3]On the most sophisticated level, advanced 4DT envisions direct linkage between the aircraft's flight management system and the ATC service provider's 4DT automation. *See* S. Ramasamy, R. Sabatini, A. Gardi, T. Kistan, "Next Generation Flight Management System for Real-Time Trajectory Based Operations," Applied Mechanics and Materials, vol. 629, pp.344-349, Trans Tech Publications, 2014. DOI: 10.4028/www.scientific.net/AMM.629.344, https://www.researchgate.net/profile/Alessandro-Gardi/publication/264742599_Next_Generation_Flight_Management_System_for_Real-Time_Trajectory_Based_Operations/links/540acf870cf2f2b29a2cd767/Next-Generation-Flight-Management-System-for-Real-Time-Trajectory-Based-Operations.pdf ; A. Gardi, S. Ramasamy, R. Sabatini and T. Kistan, "CNS+A Capabilities for the Integration of Unmanned Aircraft in Controlled Airspace," Proceedings of IEEE International Conference on Unmanned Aircraft Systems (ICUAS 2016). Arlington, VA (USA), June 2016. Print ISBN: 978-1-4673-9333-1,

- ***The current air traffic controller workforce should be carried forward in some form into NextGen ATC.*** Not necessarily. This is a political--not technical--imperative, without any obvious underlying scientific, engineering, or even business rationale. Truth be told, air traffic control skills are not transferable to the mathematical and engineering requirements of 4DT software design, operation, and maintenance. And inserting humans unnecessarily into automated processes could introduce the opportunity for human error where it would not otherwise exist. Even as a business matter, it makes no sense to create a role for workers being replaced by automation. It would be the rare private company that would do this, and certainly shareholders would complain about the unnecessary expense. Likewise, there is little logic in expecting the Federal government to do it.
- ***Today's ATC system must evolve, not transform, into a modernized end state.*** To the contrary, piecemeal upgrade of the NAS (e.g., in segments of airspace by classes, or groups of operators, or individual operators by exception), or by insertion of new technologies and procedures into legacy or obsolete environments, can be the most difficult and costly of approaches. The evolutionary approach invariably introduces innumerable incompatibilities of equipment and software, problematic boundary issues between modernized and legacy airspace, and disruptive and expensive iterative equipage investments for aircraft operators.[4] In fact, it is far from clear that evolving today's NAS into to the optimal future end state is even possible. To date, FAA has not articulated a convincing architecture and evolutionary road map that achieves a NAS-wide environment capable of opening access to the entire NAS, on a fair and equal basis, to all operators, be they legacy or newcomers. As a historical matter, recollect that the idea of evolutionary modernization is a newcomer to the development of air traffic control. Until the late 1990s, major NAS improvements, such as the inception of positive control and introduction of radar, came about through transformational programmatic upgrades.[5] To the extent there is legitimate trepidation

https://www.researchgate.net/publication/304183469_CNSA_Capabilities_for_the_Integration_of_Unmanned_Aircraft_in_Controlled_Airspace .

[4] Aircraft equipage issues, which as a political and practical matter have often been a barrier to evolutionary improvements, would be minimized for operators in a changeout to NAS-wide automated 4DT. In 4DT, interfacing operator equipage could be made uniform and operable across the entire NAS, and confined to relatively less expensive technology that merely communicates the desired flight path to the 4DT automation, and receives back and acknowledges instructions.

[5] *See* for example, the institution of positive control in 1935, the introduction of radar in the mid-1950s. https://www.faa.gov/about/history/photo_album/air_traffic_control#:~:text=Early%20Airway%20Traffic%20Control,facility%20during%20the%20following%20year . *See* also, the NAS Plan's concept of Advanced En Route Air Traffic Control (AERA) in the mid-1980s, forerunner of today's 4DT automation, which in its end state was intended as a change out of the existing human operated ATC system. Federal Aviation Administration National Airspace System Plan, September 1989, p. III-38, https://www.safeaccess4uas.com/library.html . It was only in the 1990s, when over-long development and procurement cycles failed to keep pace with accelerating technologies, that FAA introduced the concept of evolutionary improvements as a replacement for programmatic upgrades. *See* Pozesky, Martin T., "Seven Practical Postulates to Deal with the Requirements Process and Rapidly Changing Technology," *Journal of Air Traffic Control,* January-March 1993, p.8, https://www.safeaccess4uas.com/library.html . This approach features insertion of off-the-shelf technologies, constantly refreshing requirements, and continual cycles of design, manufacturing, and implementation. It precludes the idea of revolutionary NAS-wide operating concepts, and wholesale changeouts of ATC equipment and operating paradigms. Mr. Pozesky says, "Beware of the Far Away 'End State'….What *is* needed, however, is an overall *architecture* which can evolve to the future and will protect the future options. There is just no way to do this perfectly; to insure[sic] that all future contingencies will be covered…." Although thoughtfully adopted, in retrospect this evolutionary approach is now proving a barrier to transformational thinking that will deliver the NAS we are finding necessary today.

about flipping the switch from the current ATC system to fully-formed 4DT automation, the new system might benefit initially from limited implementation in specified altitudes, to gain experience and build confidence in its reliability.

- ***Legacy operators/operations must be protected at the expense of new entrants.*** The current regulatory assumption favors partitioning off and segregating airspace[6], leaving only the crumbs of uncontrolled airspace to new entrants. This practice relegates them to low altitude, sparsely populated, or sanitized areas where they can avoid disturbing legacy commercial and general aviation. And even in those areas, newcomers are assigned the responsibility, technical challenge, and expense of avoiding incumbents. New entrant operators can rightfully object to this unlawful,[7] discriminatory treatment. It limits the utility of their aircraft, thereby diminishing their investments, not to mention effectively suboptimizing emerging new technologies, and discouraging potential service options that may prove better tailored and cheaper for customers. The better National goal is creation of one airspace continuum, open to all on an equal basis.
- ***The private sector does things better than government, so everything should be privatized, or devolved to private sector operation.*** To the contrary, there are things that only government can do, or that government does best, and should do. Among those functions are National defense and law enforcement, safety regulation and enforcement, and the judiciary. But also, government authority is essential when it comes to legislating, regulating, or adjudging fairness, equality, and equity of access to public assets among competing citizens. On the other hand, private individuals and corporate bodies cannot, nor should they be expected to subordinate their individual--or their stockholders'—interests in favor of the public good. Air traffic control, because of its safety responsibility and inherent function of arbitrating competing demands for airspace access and priority, is one of those functions that arguably is best performed by government.[8] Moreover, delegating ATC functions to the private sector requires overlay of complicated and contentious fitness and regulatory oversight mechanisms for assuring safety and fairness of access--mechanisms that add layers of cost and complexity to the entire enterprise, even if they can be agreed to by stakeholders. And finally, as a design issue, devolution of ATC to various private service providers could immeasurably increase the difficulty of achieving a seamless NAS continuum, particularly if the idea is to parse out domains of airspace to quasi-regulatory private "authorities" enacting their own

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[6] In its "Task Group 13 Feedback on FAA's AAM Near-Term FAA Strategic Framework for AAM Near-Term Operations, Final Report 10-20-2022" (p.13, p.21 of the Briefing Book), the Airspace subgroup of the FAA's Advanced Aviation Advisory Committee rejected FAA's posed study question of "Why divide the airspace?", reframing as the proper inquiry: "Should the FAA investigate safe integration over segregated airspace?" https://cms.faa.gov/sites/faa.gov/files/AAAC-Meeting-Public-eBook_10202022.pdf

[7] "…**(d) Consistency With Air Commerce and Safety Policies.—**
Each airport and airway program should be carried out consistently with section 40101(a), (b), (d), and (f) of this title to foster competition, prevent unfair methods of competition in air transportation, maintain essential air transportation, and prevent unjust and discriminatory practices, including as the practices may be applied between categories and classes of aircraft."
https://www.law.cornell.edu/uscode/text/49/47101

[8] This is not to say that private sector concepts should not be emulated in government-operated ATC where they make sense. For example, in a seamless NAS, open equally to all classes of operators, a fully automated non-monetary auction process could mediate competition for airspace right of way, empowering operators to self-determine prioritization of their own flights and routes, both strategically and, ultimately, in real time tactical operations. Such a mechanism could be designed to prioritize, and thereby protect, National Defense, EMS, disaster relief, and law enforcement operations.

variety of airspace regimes and procedures. Such a vision, currently embodied in the NASA UTM Concept of Operations,[9] may prove impossible of detailed design.

- ***The only acceptable goal is perfect safety.*** Pretty much everyone acknowledges that "zero accidents,"[10] like the Holy Grail, is a myth. Nonetheless, this myth persists as an "aspirational" goal. Even subconscious attachment to this ideal, however, is problematic. It discourages anyone from proposing or advocating realistic, community acceptable safety goals and standards, for fear of being perceived as callous, heartless, or inhumane. And it traps certification applicants and industry standards-setting bodies in frustrating, wasteful do-loops, trying to please regulators who seem never to be satisfied with anything short of zero risk. To the contrary, opening new frontiers of airspace to unprecedented vehicles requires everyone to agree that the right approach to safety is not slavish pursuit of the perfect, but rather reasonable, publicly acceptable target levels-of-safety that are capable of demonstration through objective data.[11] Implied in such standards is official acknowledgment that there is, and always will be, some residual risk, which can and should be addressed through mandatory third-party liability insurance or self-insurance.

So, what can a professional or company do to prevent acceptance of unwarranted assumptions that lead to wrong, costly, and sometimes unfair policies, decisions, and designs in ATC transformation? First is, overtly and publicly, to challenge such assertions whenever they are spoken or written, and demand that the proponent support their statement with facts, data, and analysis. Second, others must support the challenge, even if their first instinct is to disagree with the challenge on the merits. Each of these maxims may, or may not, be applicable in a particular context, but there is inherent value in forcing clarification of issues, examination of underlying science and data, and exploration of alternatives, regardless of the outcome, and every professional should respect that process. The price of failing to do so is too high.

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[9] https://www.faa.gov/sites/faa.gov/files/2022-08/UTM_ConOps_v2.pdf

[10] https://apps.dtic.mil/sti/pdfs/ADA307192.pdf

[11] Experts have recommended that FAA consider as "acceptably safe" those operations that can be performed at a level of accidents and mishaps already prevailing in the subject piece of airspace, which it can be asserted the public already accepts as reasonably safe. FAA Order 1100.161A, Ch. 5.1 (2/28/2020), https://www.faa.gov/documentLibrary/media/Order/FAA_Order_1100.161A.pdf . *See* also, European Union Aviation Safety Agency (EASA) Opinion No. 01/2020 Implementing Regulations, which in Article 2(b) states as the safety standard objective to "maintain the current level of safety for manned aircraft." https://www.easa.europa.eu/sites/default/files/dfu/Draft%20COMMISSION%20IMPLEMENTING%20REGULATION%20on%20a%20high-level%20regulatory%20fram....pdf. The Unmanned Aircraft Systems Beyond Visual Line of Sight Aviation Rulemaking Committee Final Report, March 10, 2022 (p.65) recommends that "The acceptable level of risk (ALR) for UAS should be consistent across all types of operations being performed, and no more restrictive than the accepted fatality rates of general aviation." https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/UAS_BVLOS_ARC_FINAL_REPORT_03102022.pdf

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