AVIATION IMPLICATIONS: COVID-19, THE GREAT RESET & THE FOURTH

by

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A Graduate Capstone Project Submitted to the College of Aeronautics,
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of the Requirements for the Degree of
Master of Science in Aeronautics

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This Graduate Capstone Project was prepared under the direction of the candidate's
Graduate Capstone Project Chair, Mark Miller, Ed.D.,
Worldwide Campus and has been approved. It was submitted to the
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Date

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"This is it. This is how it's done. It's narrative. People have been implanted with a story that makes them believe that the fundamental abrogation of their humanity is actually their salvation."

James Corbett

Abstract

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Title: Aviation Implications: COVID-19, the Great Reset & the Fourth Industrial Revolution

Institution: Embry-Riddle Aeronautical University

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The SARS-CoV-2 situation served as a shock to worldwide economies while simultaneously decimating global international air travel beginning in early 2020. As such, the efficient and profitable U.S. domestic airline industry suffered greatly, proving just as vulnerable to the fall out effects that resulted in the collapse of passenger enplanements. Emerging from the ashes of these historic events that imploded all economic sector activity were calls from sovereign, corporate, and NGO figureheads, to fundamentally alter the economic landscape going forward. These ideas, labelled as the Great Reset, encouraged all citizens to reimagine work in every possible sector, including the airline industry. The key problem statement for this research project is that the implications of the Great Reset are unknown as to how it pertains to the professional pilot employment landscape within the Part 121 airline passenger and air cargo industry. The intent of this project is to present a qualitative exploration of the potential implications of how the Great Reset impacts the U.S. domestic airline industry given the adverse effects SARS-CoV-2 had on the global aviation industry thus far and how unfolding technologies such as adaptive automation may influence the flight decks of tomorrow. The research question asks to what extent does the Great Reset influence the future employment landscape for professional pilots in the Part

121 passenger and air cargo industry? Major literature review themes include the merging of the human element with advanced technologies, future flight deck designs, adaptive automation, Unmanned Aerial Systems (UAS), and single pilot cargo and passenger carrying operations. This project leverages a qualitative design with a combination narrative inquiry and content analysis.

Keywords: World Economic Forum, the Great Reset, Fourth Industrial Revolution, Adaptive Automation, U.S. Part 121, Biosecurity, Public-Private-Partnerships.

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Chapter I

Introduction

Since the dawn of powered flight, technology has consistently played a role in forwarding aviation onto the next level of achievement, be it speed, efficiency, power, height, new capabilities, or any combination thereof. In addition, technology served to increase the productivity of the human pilot while simultaneously decreasing their respective workload through various forms of automation on the flight deck. Combining newfound capability with automation in the aviation sense ultimately played a direct role in influencing how many human operators remained as a necessary member of the flight deck crew make up, with the preponderance of the trend decreasing in number as time advanced after the dawn of the jet age in the 1950's to 1960's (Fadden et al., 2015).

Existing aircraft configurations in the years prior to the advent of the jet age typically required a crew of five persons: two pilots, a flight engineer, a navigator, and a radio operator (Vu et al., 2018). Certain variations to the above crew make up existed depending upon aircraft size and configuration, its associated mission, and whether it remained over land or executed long distance overwater flights. With the jet age simplifying and improving aircraft engine simplicity, performance, and reliability over their piston engine counterparts, assigned flight engineers soon leveraged their newfound time to monitoring aircraft sub-components and systems beyond the jet engine itself. What is more, technological advances in aircraft avionics, both for communications and navigation soon negated the standard navigators and radio operators beyond the 1960's and 1970's, with the opening of the 1980's firmly within the two-pilot standard crew make up (Fadden et al., 2015).

Considering advancing technology improving aircraft systems reliability to such an extent that it directly influenced the reduction of minimum required flight deck crew members since the 1950's, how long would it take to further reduce required flight deck crew members down to just a single pilot? Given the some-odd thirty years that elapsed (1950-to-1980) for the progression of the two-pilot crew to firmly establish itself within the airline industry, it should be noted that a full forty-plus year time span has passed since the two-pilot standard became widely accepted. If history's past performance offers any clues to what sweeping future potential changes to airline flight crew standards lay in store, it may appear high time for a new standard to come to the fore.

While the incessant march of time and inevitable technological advancements that go with it may simplify the arguments from those pushing for a Commercial Single Pilot Operations (CSPO) model to be adopted by some segments of the U.S. domestic airline industry, the simple truth is that it is not so simple after all. To illustrate this point, one must take a strategic view of human flight deck performance in the totality of the evolution of aircraft automation and flight instrumentation from the most basic of needles and dials, to the most awe-inspiring digital displays so prevalent today and consider the changes in cognitive loading experienced by pilots across this time spectrum. In this regard, most ironically, human cognitive loads have actually increased with the advent of more advanced aircraft automation and digital displays communicating key information to the pilots despite the fundamental purpose of this automation and digitization being designed to reduce pilot workloads (Miller & Holley, 2018). What is more, referencing a multitude of research studies going back to 2009 in which explorations into machine learning, adaptive automation, and artificial intelligence indicates that, while impressive gains within these categories presented themselves since that time, to-date, nothing has been developed nor invented that can completely replace human intuition wholesale (Tweedale, 2014).

Despite this, meaningful gains and discoveries since 2009 presented intriguing findings that served to influence future aircraft automation research trajectories. Beginning with the development of neural networks as part of a wider plan to develop Artificial Intelligence (AI) and machine learning, researchers noted increased capabilities when teaming basic AI architectures with human counterparts. This human-machine team concept routinely outperformed AI based machine combinations at solo or machine-only team-based tasks (Edelman & Fleischer, 2009). What is more, numerous other research studies drew the same conclusions when exploring the limitations of human cognition in the face of increased digitization in recommending some sort of adaptive automation or a human-machine team concept (Miller & Holley, 2018; Schutte, 2017; Vu et al., 2018).

Beginning with the findings outlined in Edelman & Fleischer (2009), this study demonstrated the increased performance that could be realized through human augmentation. Tweedale (2014) outlined the limited success of machine learning at the time and posited that nothing to-date could displace human intuition, and instead recommended further study into the human-machine team concept. Perhaps most revealingly, a study conducted by Aricò et al. (2016) successfully demonstrated the intervention of adaptive automation programs in assisting overworked Air Traffic Controllers. Continuing with Schutte (2017), this study highlighted the dichotomy of advanced aircraft automation designs as a root cause of human cognition challenges and further recommended future research into human-machine team conceptual designs. Furthermore, Vu et al. (2018) referenced a study by Shively et al. (2017) wherein the best path forward towards CSPO may lie in what is termed "Human-Autonomy Teaming" or HAT. This very thought process is also adopted by the study titled *Adaptive Automation and the Third Pilot* wherein human pilots work as a team with an AI based team member, however, diverges from other studies in that two pilots occupy the flight deck, and the automated assistant acts as a third crewmember (Cahill et al., 2018). Finally, a study by Tokadli et al. (2021) outlined the results of HAT and pilot preferences in interacting with HAT during various Single Pilot Operations (SPO) scenarios.

Taking into consideration the many studies into flight deck automation and HAT technologies, it is important to view these findings in comparison to recent global events affecting worldwide air travel and what the impact of this research portends for the aviation industry in a post-COVID world. Most notably, Non-Governmental Organizations (NGO) such as the World Economic Forum (WEF) and other corporate entities have vocally called for an acceleration of these advancements and the merging of humanity with technology as a source of solutions solving a myriad of problems (Schwab, 2017). However, viewing the measured approaches to flight deck automation advances amongst the selected sample of research studies in this paper and comparing them to the strategic views touted within all WEF literature should breed concern for all stakeholders who participate in or benefit from the U.S. based Part 121 aviation industry. Most or all the technologies above are deemed Fourth Industrial Revolution (4IR) advancements in some form or fashion and stand to serve as the sweeping catalyst that very well may overhaul flight crew standards to the realized CSPO model. What is more, these developments, coupled with influential NGO, corporate, and sovereign state policies to implement comprehensive changes under an initiative termed the Great Reset may expose the traveling public and all citizens to undue risk (Schwab & Malleret, 2020).

Significance of the Study

This study is significant in that it serves to stir thought-provoking discussions as to how strategic WEF visions affect the implementation of 4IR technology within the aviation industry. In addition, it serves to highlight how legacy regulatory frameworks have historically bolstered aviation safety in the face of increasing technological advancements, and where gaps and failures exposed the public to aviation risks. Further, these facts should be noted when taking into account the calls from WEF literature that historical regulatory frameworks served as obstacles to technological advancement and stifle the implementation of 4IR strategies. The WEF's solution to this perceived problem lies in the establishment of Public-Private-Partnerships (P3) as the guiding principle to implement 4IR technologies not only in the global aviation industry, but within all industries the world over (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020). The P3 model presents well as a viable alternative to the seemingly stove-piped regulatory constructs elaborated about in all the WEF literature, and even served as an early architype path to success in forging today's standard two-pilot crew model. Whether or not it was known as a "Public-Private-Partnership" (P3) back in the 1980's, these facts remain as an acknowledgement of the hard work completed by Boeing, NASA, the FAA, and other U.S. aviation industry players that denoted the P3 nature of the two-pilot crew endeavor (Fadden et al., 2015).

Despite all the seemingly pre-conceived solutions to pre-determined problems championed by the WEF, there are voices, both within and without the aviation industry expressing concerns regarding implications that come with the P3 model of implementing sweeping technological changes affecting flight deck crew standards in an already safe and efficient Part 121 passenger and air cargo industry (ALPA, 2019). These concerns stem mainly from the Air Line Pilots Association, a union representing professional pilots across many main line carriers within the U.S. and Canadian aviation industries (ALPA International, n.d.). In 2019, ALPA released a white paper titled *The dangers of single pilot operations* and outlined concerns surrounding the push for CSPO. This particular piece of literature is significant in this study in that it was published in a pre-COVID world and served as prescient marker of strategic calls to come post-pandemic (ALPA, 2019; Schwab & Malleret, 2020).

Lastly, the significance of this study serves to highlight the aligning common threads of concern adopted by organizations within the aviation industry such as ALPA, and other apprehensive citizen interest groups taking notice of the potential loss of public voice and dismantling of legacy regulatory frameworks that historically served as bulwarks of public safety. By implementing the P3 model as part of an overarching plan to adopt 4IR technologies having long lasting societal impacts, beginning with the aviation industry, and extending beyond it, it is fascinating that these two disparate interest groups would align in this fashion in a post-COVID world to highlight concerns impacting both flight safety and citizen well-being (ALPA, 2019; Winter Oak, n.d.).

Statement of the Problem

The problem to be explored in this research project is that the implications affecting the Part 121 professional pilot employment landscape, brought on by the Great Reset and other 4IR initiatives, are currently unknown. In addition, the initial collapse of passenger enplanements the world over, spearheaded by the spread of COVID-19, led to drastic U.S. government interventions to sustain the American domestic airline industry through various COVID-19 related relief packages funded by taxpayers. Some of these programs and schemes assisted in the prevention of massive furloughs and lay-offs, with professional pilots and flight attendants being paid a fraction of their regular monthly pay to not work (Shepardson & Rucinski, 2021). However, considering the WEF's Great Reset initiatives, 4IR technological advancements influencing the application of CSPO models, and the continuing SARS-CoV-2 negative impacts to the air cargo and passenger airline industry in totality of a wider employment picture, a more in-depth exploration is required to ascertain just exactly what the future results may be for this key transportation industry.

Purpose Statement

The purpose of this qualitative study is to highlight key technological advances spurred on by the 4IR movement and how these advances may influence future flight deck automated architectures and operations. Considering the COVID-19 situation, repeated calls for a Great Reset and an acceleration of the merging of technological capabilities with human physical and digital identities serves as a future fundamental baseline to drastically alter these flight operations extending into the Part 121 air cargo and passenger airline industry. In exploring these parallel threads between technology, aviation, and the human condition, the goal is to tie it all together to determine how each and every one of these variables can influence the future employment prospects in the U.S. domestic passenger airline and air cargo industries going forward.

In addition, as part and parcel of the tireless pursuit to practically eliminate risk within a multitude of operations, including aviation operations, this research will outline coming technological changes driven by the 4IR that will upend social, political, and economic life for the entire world in the name of safety and efficiency. Of note, this research intends to explore the merging of the human condition with digital identities and advanced technological capabilities to such an extent that it will fundamentally change what it means to be a human being while in the pursuit of increased safety, productivity, and efficiency.

Research Question

To what extent will COVID-19, the Great Reset and the 4IR influence the Part 121 passenger and air cargo professional pilot employment outlook from here into the future?

Delimitations

While the common themes and variables discussed in this study have global societal and industrial implications, this work solely focused on the research and studies exploring technologies that facilitate the laying of milestones along a path towards CSPO or the eventual realization of fully autonomous flight operations and the impacts therein. To this end, all technological achievements thus far were compared against the backdrop of corporate, NGO, and sovereign state calls for the accelerated merging of 4IR technologies with humanity post-COVID-19. Furthermore, additional emphasis was placed on how these advancements upend or threaten to bypass legacy regulatory frameworks in the struggle to remain abreast of increasing technological change affecting aviation operations.

Limitations and Assumptions

This exploration was limited to reviewing the implications affecting U.S. based Part 121 air cargo and passenger airline operations. In this regard, this paper held the assumption that Part 121 air cargo operations served as the natural and logical next milestone to adopt CSPO. Considering this assumption, this study also assumed that pilot's unions such as ALPA International would object to and resist all initiatives supporting a transition to CSPO.

List of Acronyms

4IR	Fourth Industrial Revolution
AAM	Advanced Air Mobility
AI	Artificial Intelligence
ATC	Air Traffic Control
ATM	Air Traffic Management
ATTOL	Autonomous Taxi, Take-Off and Landing
ALPA	Air Line Pilots Association
COVID-19	Wuhan Novel Corona Virus-2019
CRM	Crew Resource Management
CSPO	Commercial Single Pilot Operations
eVTOL	Electric Vertical Takeoff and Landing
FAA	Federal Aviation Administration

FO	First Officer
HAT	Human Autonomy Teaming
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NGO	Non-Governmental Organizations
NTSB	National Transportation Safety Board
P3	Public-Private-Partnerships
PEST	Political, Economic, Social, Technological
RPA	Remotely Piloted Aircraft
SARS-CoV-2	Severe Acute Respiratory Syndrome-Corona Virus-2
SPO	Single Pilot Operations
SWOT	Strengths, Weaknesses, Opportunities & Threats
UAS/sUAS	(small)Unmanned Aerial Systems
UPP	UTM Pilot Program
UTM	UAS Traffic Management
WEF	World Economic Forum

Chapter II

Review of the Relevant Literature

The literature themes that follow cover a wide array of books, studies, peer-reviewed journals, and articles that highlighted the progressing technological advancements surrounding flight deck automation, digital displays, AI, and the technologies underlying the many notable UAS achievements taking place at quickening rates. In addition, these achievements underscore the premise of CSPO and how they can ultimately influence fundamental changes to future flight deck standards. What is more, NGO strategic views and initiatives further cement the seeming inevitability of these sweeping technological changes that not only represent the possible evolutionary overhaul of the aviation industry, but also of humanity itself. Finally, critical discussions on how regulatory frameworks should grapple with these changes and the larger impacts to the Part 121 air cargo industry were taken into context amidst calls for spearheading the P3 model as the sure-fire solution to resolving a multitude of political, societal, and economic challenges.

Evolution of Digital Flight Displays & Aircraft Automation

Prior to the jet age, aircraft flight instrumentation and configuration standards proved as diverse as the number of aircraft manufacturers available and presented challenges to the pilots learning to operate these various aircraft, notwithstanding the difficulties that come with training others how to cope with these disparate set ups. As such, it was not until the 1950's until a true science-based approach was explored to truly understand how flight deck instrumentation and configurations affected pilot performance (Fadden et al., 2015). With continued refinements in flight deck avionics and displays beyond the 1980's, pilots enjoyed ever increasing levels of situational awareness and aircraft automation. However, what was not known early on that has more recently come to light were the effects of digitization combined with automation that placed excessive burdens on a pilot's ability to contend with increased cognitive loading (Miller & Holley, 2018).

Situational Awareness & Cognitive Loading. Over the years, as increasing levels of automation entered the flight decks, physical pilot workloads decreased, however mental workloads increased due to the mental capacity needed to monitor the automation, sustain newfound situational awareness, communicate with other flight crew members, and respond to ATC instructions (Guastello, 2013). This also proved evident when contending with off-nominal situations such as an aircraft emergency or when struggling to mentally understand a fast-paced stream of digital information. With the increased digitalization of flight deck displays coupled with increasingly capable autopilot automation, the cognitive load on pilots to monitor and respond appropriately while staying ahead of the aircraft taxed pilot's cognitive abilities. Most notably, fundamental processes in working memory as part of the overarching brain physiology point to the depletion of brain glucose and key proteins that sustain working memory and situational awareness when a pilot attempts to process a continuous stream of information derived from digital displays. In this regard, it is easy to see how the prevalence of digital displays and increased flight deck automation may result in a loss of pilot situational awareness (Miller & Holley, 2018).

Automation Surprise & Mode Confusion. Another aspect of digital flight displays, and advanced aircraft automation is the increasing prevalence of pilots suffering mode confusion and automation surprise. As highlighted by Miller & Holley (2018), despite the best automation available on aircraft today, human error can overshadow the most elegantly designed flight deck automation and still lead to mishaps. This may be easily explained through the increasing capabilities of flight deck automation, thereby relegating human pilots to mere system monitors, and thus result in the atrophy of their physical flying skills and subsequent loss of pilot confidence. In turn, this may create a vicious cycle of pilot reluctance to fly without assistance of automation (Schutte, 2017) or lack of tactile aircraft feel due to having to control the aircraft through the computer either by choice or by aircraft design (Miller & Holley, 2018).

The over reliance on automation through one form or another can confound pilots to such a degree that a misunderstanding can build to where assumptions of which automation modes were engaged, but realistically were disengaged, thus leading to a situation where neither the pilot nor the computer were flying the aircraft or making the appropriate inputs to sustain safe flight profiles. Conversely, pilot misunderstandings as to why certain automation modes disengaged through the reaching of a certain pre-programmed limitation can often surprise a pilot not prepared or unaware of encroaching conditions of these limits (Schutte, 2017).

Asiana 214 & NTSB Challenges. The Asiana 214 mishap is one occurrence in which mode confusion resulted in an aircraft accident where all automation systems were functioning properly, however, a series of pilot misunderstandings, automation complacency, and lack of confidence in manual flying skills ultimately resulted in a tragic scenario (NTSB, 2014). In referencing the National Transportation Safety Board (NTSB) accident report, rather than outline a single probable cause attributed to the accident, the NTSB was challenged in singling out single causal factor, and instead relied upon a series of professional opinions as an approximation to an accident probable cause (Miller & Holley, 2018). What the Miller & Holley (2018) study continues to outline, and referenced further below, is that the evolution of digital information intersecting all facets of what is termed the SHELL model illustrated how automation and digital displays can act as a layer of interference or "well-managed barrier" across all interfaces within the SHELL model (pg. 97, para. 2.1. The SHELL Model 2017 and the (L)-(H) Interface).

Automation Feedback to Humans. Considering the human failures in managing different levels of flight deck automation that ultimately resulted in aircraft incidents or accidents, it would make sense to begin efforts to program the human out of the automation loop in an effort to increase flight safety. However, according to a study by Schutte (2017), this is fallacy when considering the design architecture of advanced automation and how the human element is primed for maximum engagement within the aircraft system. Also consider the many interventions of the human element in the elegant and complex design phase of computer code that governs aircraft automation. Further still, consider the potential errors inherent in designing that code. Regardless, whether removing the human from the flight deck, in the bid to increase flight safety through automation alone, greater human intervention inevitably is required through the automation variable (Schutte, 2017).

Another consideration to account for involves designing aircraft automation architectures to disengage and defer to human control only at the bitter end of some predetermined limitation. This sets the human pilot up for failure at the height of a nonnominal scenario, and at a distinct moment when the human may be at a low point in the Yerkes-Dodson Law curve, where low performance meets low stress and low arousal (see Figure 1). Nowhere is this more poignant than in the Colgan 3407 mishap wherein the autopilot disengaged after reaching an engagement limit due to a low-speed condition, startling the pilot into an improper aircraft control response that ultimately aerodynamically stalled the plane at such a low altitude that deemed recovery impossible (Schutte, 2017). What is more, in the current aircraft automation architectural environments wherein the vast majority of flight functions are spoken for by the autopilot, this relegates the human pilot to standby for subsequent automation failures; a role in which humans are poorly suited for given ripe opportunities for a startled and, more likely than not, improper response; much like that found in the previously discussed Colgan 3407 mishap (Schutte, 2017).

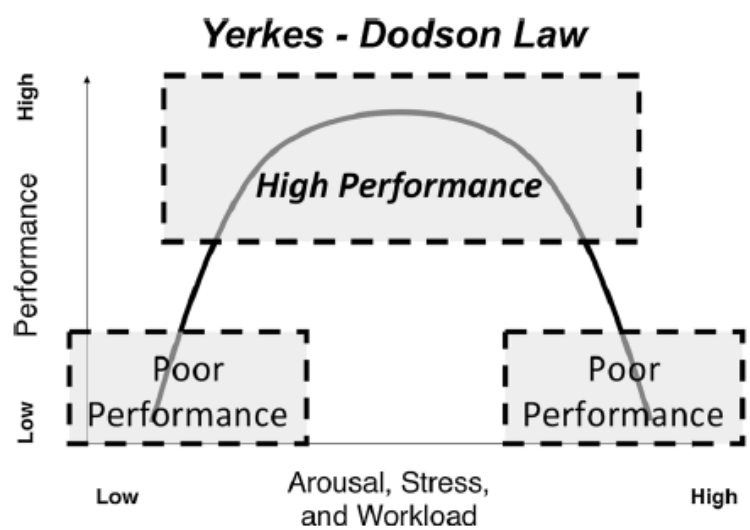

Fig. 2 Yerkes–Dodson inverted U of performance

Figure 1. The Yerkes-Dodson Law Curve

Note: Adapted from Schutte (2017). Figure 2. Yerkes-Dodson Inverted U of performance, p. 239.

To further drive the point home, it should be noted that when a human pilot rises above their ingrained infallibilities when faced with an emergent scenario and not suffer from a startled response, memory failures or complacency, it is considered normal behavior. If and when a human succumbs to the above frailties, it is labeled a failure or human error. Consequently, consider when automated systems perform as programmed and disengages when reaching some predetermined limit, it is not labeled as a failure, but considered normal performance (Schutte, 2017).

Despite the seeming dichotomy between expected automation and human performance levels in dealing with in flight emergent scenarios, the Schutte (2017) study posits an improvement to aircraft automation architecture that fosters communication and feedback between the automated system and the human pilot. Reflecting upon legacy Crew Resource Management (CRM) principles, it showed that automation architectures historically served as less than stellar crewmembers. In this regard, *How to make the most of your human: design considerations for human-machine interactions* proposed designing a new automation architecture, one that involves automation feedback to the human in the loop. The end goal here is to design a system that does not handicap the human pilot, but rather complements the relationship. The term given here is complementary automation and is one of many theories forwarded by other researchers that mentions HAT, or Human Autonomy Teaming (Schutte, 2017).

Aircraft Management & Digital Visual References. One of the consequences tied to the increasing advancement of automated systems immersed within aircraft today is the resultant loss of tactile feel that formerly served as a valuable source of feedback of aerodynamic forces to pilots. With the proliferation of digital systems, displays and information embedded through all interfaces of the aforementioned SHELL model above, this lack of tactile feedback forces the pilots to work through the digital systems layers and ultimately resort to digital visual displays in order to ascertain the present status of the flight (Miller & Holley, 2018). As stated previously in Miller & Holley (2018), flying the aircraft through the computerized systems burdens the optical channels and can easily result in cognitive overload and the rapid depletion of key brain proteins and glucose that sustains working memory.

An unfortunate manifestation of this very phenomena occurred with the Air France 447 mishap wherein the pilots became confused while struggling to process the digital information tied to a pitot system failure, which subsequently disengaged the autopilot and forced them to manually control the aircraft. In addition, the fly-by-wire control system facilitated opposite flight control inputs by the pilots occupying the Captain and First Officer stations. The lack of tactile feedback, mode confusion tied to the flight control laws, and the struggle to analyze the stream of information emanating from the digital displays resulted in a deep stall of the aircraft at high altitude, which caused its subsequent descent into the water. While the pilots did eventually realize the magnitude of the problem once attaining visual conditions, it was much too late to recover the aircraft due to low altitude (et d'Analyses and Bureau d'Enquetes, 2012).

Evolution of SHELL Model. The above Air France tragedy is driven home by the digital evolution of the SHELL model, and highlights how digitization of systems, displays, and information can form barriers that stymie human performance without the benefit of in-depth aircraft computer systems training. Looking at this mishap through the updated SHELL model also highlighted the digital barriers between the pilots and the aircraft, as referenced as the Liveware (L)-Hardware (H) interface (Miller & Holley, 2018). Figure 2 represents an iteration of how the digitization of systems affects the SHELL model interfaces (Miller & Holley, 2018).

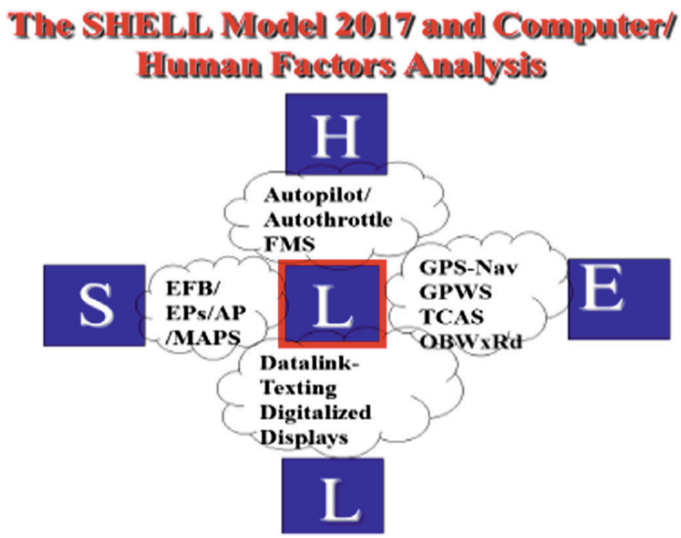

Fig. 2. The SHELL model 2017 with computer automation and information displayed by Miller in 2016 [2]

Figure 2. The SHELL Model 2017 and Computer/Human Factors Analysis

Note: Adapted from Miller & Holley (2018). Figure 2. The SHELL model 2017 with computer automation and information displayed by Miller in 2016, p. 97.

Notable UAS Accomplishments

Other literature accounted for as part of the overarching review of potential CSPO transitions affecting Part 121 air cargo industry were notable UAS accomplishments and the technology that drove these achievements. Indeed, the technology underlying UAS capabilities served to modernize the battlespace for war in addition to opening new avenues for humanitarian endeavors as well (Robinson, 2006; Whittle, 2018). More recently, efforts to safely integrate UAS into the NAS gained traction with the Federal Aviation Administration's (FAA) publishing of new regulations governing UAS flights over people and outlining requirements for remote identification standards to be adopted industry wide when the identification rules become active in 2023 (FAA, 2021). Considering the breakneck pace of UAS developments affecting the NAS of today, an overarching review of UAS firsts proved helpful in providing context of where some of the first automated systems capabilities sprang.

RPA Ocean Crossing. In April of 2001, an RQ-4 Global Hawk Remotely Piloted Aircraft (RPA) became one of the first ever trans-oceanic flights by crossing the vast Pacific Ocean from the west coast of the United States on a pre-programmed journey to Australia. The RQ-4 Global Hawk is a large high altitude UAS powered by a single turbofan engine and was designed for maximum endurance and high-altitude loitering capability. The UAS cruised at 65,000 feet above the ocean, which is much higher than most common oceanic jet traffic, and well above most convective activity known to occur over the Pacific. While entities on the ground monitored the flight's progress, no interventions were made to the flight from takeoff to touchdown (Associated Press, 2003).

Manned RPA Flight. In April 2013, the U.K. consortium ASTREA successfully demonstrated the safe integration of RPA systems as part of the National Air Transportation System (NATS). This research project leveraged a modified BAE Jetstream aircraft as a technology demonstrator and test bed for the eventual control of the aircraft via a remote operator working in conjunction with NATS controllers. The flight safely demonstrated the successful hand off of aircraft control from the pilots aboard the plane to the remote operator on the ground wherein it was safely flown and landed after a 500-mile journey across the English countryside (ASTREA, 2013).

Autonomous UAS Ocean Crossing. Following in the footsteps of the successful RQ-4 oceanic crossing of the Pacific, defense company General Atomics successfully demonstrated a trans-oceanic crossing of the Atlantic Ocean, this time using the much smaller medium-endurance MQ-9 UAS. While similar in most respects to the previous Global Hawk crossing over a decade prior, this feat differed in that it was done at lower altitudes, as the MQ-9 can only operate up to altitudes as high as 40,000 Mean Seal Level, which puts it well within range of most air transport category aircraft crossing the Atlantic Ocean. Most unique for this event however, General Atomics utilized Inmarsat satellite communications technology that ensured automated takeoff and landing capabilities (Szondy, 2018).

NAS Integration & UAS Ferry Flights. Shortly after the research conducted by ASTREA in the U.K. exploring safe integration of UAS into their NATS, stateside research efforts exploring sense and avoid technologies were undertaken by General Atomics. Building off U.S. based NAS modernization efforts and utilizing equipment found on common manned transport category aircraft, this project successfully demonstrated abilities to detect and steer clear of other air traffic convergence scenarios (Govers, 2013). What is more, in 2017, the FAA established the UAS Traffic Management (UTM) Pilot Program (UPP) as a P3 relationship exploring the avenues for the safe integration of UAS architecture in the NAS (Sachs, 2021). Shortly thereafter, NASA successfully demonstrated the ability to integrate one of their UAS into public use air space with other air traffic without the use of a chase plane to look after it in trail (Szondy, 2018). In what may be considered a military first, defense company General Atomics successfully delivered a new MQ-9 UAS to the U.S. Air Force customer at

Holloman Air Force Base, NM via ferry flight through the NAS. Previous deliveries were executed through the shipping process wherein the entirety of the aircraft was disassembled at origin, shipped via ground transportation, and reassembled at destination (Ball, 2020).

Autonomous Transport Category Aircraft Firsts. Given the epitome of all the UAS technology proliferating within unmanned systems, it was only a matter of time before some or all these capabilities were integrated into passenger carrying transport category aircraft. In June 2020, aircraft manufacturer Airbus concluded a 2-year development effort exploring their Autonomous Taxi, Take-Off and Landing (ATTOL) project. These efforts integrated fully autonomous architectures into an A350 using vision-based recognition systems to facilitate the ATTOL capabilities. The project accrued over 500 test flights and completed 6 successful ATTOL demonstrations (Airbus, 2020).

Armed UAS & "The Loyal Wingman." While the first proclaimed lethal use of an UAS occurred with the post-9/11 rollout of the War on Terror (Whittle, 2018), further refinements to the weaponization of the UAS platform did not occur until more recent times with the advent of unmanned combat jet systems and Boeing's 2019 unveiling of the Boeing Airpower Teaming System (Freed, 2019). This next generation of UAS is designed to work in conjunction with airborne manned flight platforms and has been given the nickname of "The Loyal Wingman" as one of its designated purposes is to protect the lead human-piloted aircraft, in addition to completing autonomous solo missions as well (Altman, 2021). With the first flight of the autonomous fighter jet completed in March 2021, this next level of autonomous UAS capability proved noteworthy in the larger unfurling of HAT trends (Altman, 2021).

Research Exploring Adaptive Automation

Reviewing research efforts into adaptive automation since 2009 revealed many notable discoveries and themes that influenced the trajectory future explorations undertook on how best to design automation architectures using AI and other adaptive systems leveraging neural networks and machine learning. Early on, it became clear that the integration of humans and machines in alignment with the HAT concept greatly improved performance in comparison to machine only combinations (Edelman & Fleischer, 2009). Further challenges in the development of adaptive automation include how best to design a system that measured and responded to changes in human physiology and cognitive loads to such an extent that the automation could first sense the change, then assume certain tasking that best augmented human performance (Arico et al., 2016). Considering successful automation interventions in ATM scenarios, the next natural step followed in determining how best to integrate these models in a flight deck scenario. Most notably, each prospective idea posited that the best path forward required following the HAT model rather than the outright elimination of the human element from the flight deck (Schutte, 2017; Cahill et al., 2018, Tokadli, 2021).

Brain Based Devices & The Human-Machine Team. In the study titled *Brain-based devices, an embodied approach to linking nervous system structure and function to behavior*, researchers Edelman and Fleischer (2009) highlighted the endeavor of team sports as an approach to bridging the human-machine gap with their ultimate goal of having a human soccer team compete against a team of autonomous humanoid soccer players by 2050. To this end, they utilized the sport of "Segway Soccer" to successfully demonstrate the use of both humans and machines on the playing field to achieve unity of effort (i.e., same team). They found that when teaming humans with an automated brain-based device, this combination defeated other machine-only based teams on the soccer field across five demonstrations and obstacle courses (Edelman & Fleischer, 2009). Referencing successful ground-based team-oriented tasks leveraging the HAT model, future research endeavors then reflected this under more aviation specific settings (Arico et al., 2016).

Passive Cognitive Load Monitoring. In the study completed by Arico et al. (2016) adaptive automation assisted an experimental group of air traffic controllers through a series of sequentially complex tasks and measured brain wave patterns and intervened to assist overwhelmed controllers based on certain parameter thresholds. The study's conclusions revealed important findings that outline successful integration principles for future research. The first of these conclusions conveyed the successful ability of adaptive automation to effectively discern between low workload and high workload tasks based upon the brainwave readings from the subject air traffic controller. Second, the adaptive automation framework successfully sensed increasing controller workloads and intervened on behalf of the task saturated controllers based upon a predetermined set of thresholds to such an extent that it prevented both an underworked and overworked condition, which lent credence to the principles above when highlighting the Yerkes-Dodson Law Curve in Figure 1. Lastly, and perhaps most significantly, this adaptive automation design not only effectively reduced overall controller workload levels, but it also effectively increased the execution of all task performances (Arico et al., 2016).

Adaptive Automation Models. Considering the success of the ATC based adaptive automation experiments, a few studies recently outlined proposed models that served to modernize aircraft automation to such an extent that it could perform as an effective crew or team member, rather than remain as an architecture requiring constant monitoring from the pilots. While all these studies outlined a unique approach to the HAT model, only one researched the use of adaptive automation in facilitating Single Pilot Operations (SPO) (Tokadli, 2021). Each concept championed modernization of automation feedback to humans to such an extent that the system is effectively serving as another crew member (Schutte, 2017; Cahill et al., 2018; Tokadli, 2021).

While outlining the shortcomings of presently constituted aircraft automation architectures and the adverse effects this plays on human pilots, the researcher also highlighted that present-day cutting-edge technology and machine learning algorithms cannot match a human's ability to serve as the line of last resort in dealing with exceptions beyond the automation's programming. In this regard, Schutte (2017) proposed a new automation architecture titled "SAFEdeck" wherein the automation should adopt an environment of open communication with the pilot, such as advising the flight crew should abnormal or excessive forces to maintain a certain flight profile occur (pg. 245, para. 5.5 Example-SAFEdeck). This is a departure from the way aircraft automation is built into today's aircraft, wherein the automation disengages, sometimes inexplicably due to the exceedance of predetermined limits. In re-envisioning aircraft automation, Schutte's (2017) framework intended to capture six overarching themes that keep the human in the loop and at the top of the Yerkes-Dodson Law Curve.

There are six major principles involved with the Schutte (2017) SAFEdeck architecture. The first involves the idea of pilot flying skill preservation using the primary flight controls to direct the automation rather than rely upon automation mode control panel or flight control panel interfaces. The second principal combats mode confusion and complacency by interfacing the pilot through all heading, altitude and or speed changes. The third integrates a memory and data recall architecture to serve as a backup to the pilot in combating human error and forgetfulness. The fourth reimagines flight path data representation on digital displays that present appropriate courses of action for the pilot to choose. The fifth principle has the automation and pilot serving as backstops to both the variable's performance, backing one another up in preventing error. Finally, the last principal involves programming a degree of system self-preservation to prevent Controlled Flight into Terrain (CFIT) accidents or landings from unstable approaches (Schutte, 2017).

Another model proposed is titled A-PIMOD which is an acronym for "Applying Pilots' Model for Safer Aircraft" (Cahill et al., 2018; pg. 4, Introduction). Cahill et al.'s (2018) model is different in that it does not propose modifying flight deck crew standards away from the current two-pilot model, but instead intends to augment this standard with a third pilot or crewmember as part of a collaborative team designed with safe mission accomplishment as the primary goal. Under this framework, the concept is to monitor many variables that include aircraft state, mission status, pilot performance that includes physiological and psychological states, in addition flight experience or background. The purpose of measuring these variables is for the purpose of the adaptive automation to continuously calculate risk-based exposures as to the safety of the flight. In acknowledging the human condition, this model does not necessarily push to prevent the occurrence of human error, but rather is designed to recover from human error before a mishap occurs. Most interestingly, this study highlighted the importance of the adaptive automation to perform in a manner consistent with normal human social interactions in the hopes of becoming a trusted agent in the multi-crew environment and deems this subject worthy of further research (Cahill et al., 2018).

The last exploration into adaptive automation using the HAT model involved a study titled *Evaluation of playbook delegation approach in human-autonomy teaming for single pilot operations* wherein the researchers utilized a playbook interface to study pilot performance under a SPO scenario (Tokadli et al., 2021). This study proved unique in that it specifically explored adaptive automation designs with effective SPO in mind, but also highlighted the possibility of CSPO and the format pilots prefer in interacting with adaptive automation under a notional CSPO environment. While the primary focus of this research involved validation of the playbook format as a viable interface between the pilots and the automation architecture, this study highlighted common themes found in previous adaptive automation explorations. These included subject pilot preferences denoting a more human-like communication experience to build trust in allocating more tasks to the adaptive automation, in addition to preferences of having a true human copilot to assist in the flight in addition to working with the adaptive system. This is poignant when considering the previous two examples included a two-pilot flight deck teaming up with an adaptive automation framework despite the SPO focus of the study (Tokadli et al., 2021).

Explorations into CSPO

Considering the above adaptive automation explorations, both accounting for dual- and single-pilot environments, certain studies researched how a CSPO framework could look like. Furthermore, the study undertaken by Vu et al. (2018) highlighted cost concerns tied to flight crew operating expenses in addition to a perceived pilot shortage as primary drivers for justifying the transition to a CSPO model. In *Single pilot operations in domestic commercial aviation,* various SPO concepts of operation are reviewed to determine the best framework as part of an overarching CSPO design (Vu et al., 2018).

Ground vs. Flight Based Models. As part of a technical interchange meeting conducted at the NASA Ames Research Center in 2012, a series of research areas surfaced that would ultimately form the operational concept trajectory of CSPO. From these themes, a ground-based and flight-based model were discussed. Underlying both models would be an architecture of adaptive automation, remote piloting capability, or some combination thereof that would facilitate the CSPO framework. Of note, the purpose of interpersonal relationships between the pilot and copilots were discussed in the light of additional roles human copilots have outside of official duties such as fostering situational awareness, supporting crew decision making, combating boredom, and managing stress. The research article remarked the absence of these cues as important sources of future research when exploring CSPO (Vu et al., 2018).

In reviewing ground-based CSPO concepts, the construct of current UAS operational tactics were considered as to how remote piloting techniques could best serve the CSPO idea. However, it was quickly discovered that legacy UAS team concepts held vastly different priorities that did not address paying customers aboard a flight controlled by a remote pilot station. What is more, other referenced research pointed to difficulties in flight crew communications when both the pilot and copilot were physically separated, much how an onboard Captain and Remote FO situation would play out. Communication challenges sourced from the lack of non-verbal cues that are commonly enjoyed in standard two-pilot crew configurations. Furthermore, role confusion abounded due to uncertainty surrounding task assignment and task completion due to a lack of non-verbal cues. What is more, economic concerns regarding the relocation of the FO from the flight deck to some remote pilot base made sense if the remote FO could assist with other airborne flights or conduct other tasks simultaneously. Finally, and perhaps most revealingly, this study found that once a remote FO focused on an onboard Captain in need, additional duties such as dispatch tasks left their purview (Vu et al., 2018).

Addressing flight-based CSPO concepts, the Vu et al. (2018) study reviewed HAT principles that echo other adaptive automation principles previously mentioned earlier in this paper. To this end, the study reiterated the importance of automation serving as more than a replacement of pilot function, but to act as functional crew member alongside the pilot. In addition, the open flow of communications and automation feedback to build the shared mental model of flight and mission status while the human pilot remains as the operational director, being assisted by the adaptive automation as being of paramount importance (Vu et al., 2018). Further echoing previous research study methodologies exploring adaptive automation, the Vu et al. (2018) paper replicated the use of a tablet-based playbook under the flight-based SPO concept to review pilot reactions to off-nominal scenarios.

CSPO Initial Conclusions. Whereas a number of adaptive automation and CSPO concepts explored thus far revealed a variety of approaches to meeting SPO goals, the Vu et al. (2018) study concluded that “no real show stoppers” prevent the reaching of a viable CSPO concept (pg. 759, Feasibility of the Single Pilot Concept and Future Research Needs). In addition, further conclusions acknowledged that future adaptive automation capabilities essentially need to perform all functions presently executed by human pilots. Noting this lack of present-day architecture and the gap between it and future performance needs, the study concluded the need for continued research and development for autonomous tools that support SPO (Vu et al., 2018).

ALPA & CSPO. Perhaps in response to proliferating research exploring adaptive automation and SPO concepts, the Air Line Pilots Association, International published a 2019 white paper outlining their stance against CSPO. Outlined in *The dangers of single pilot operations,* ALPA highlighted a number of key points that marked this concept as unnecessary, premature and dangerous. Of note, the ALPA (2019) position paper conveyed the necessity of having two pilots on the flight deck, that presently entertaining CSPO was not worth the relative risk in comparison to high safety levels enjoyed by industry, demonstrated public opinion unsupportive of shifting to a CSPO model, remaining infrastructure and technological obstacles in implementing CSPO in addition to cybersecurity vulnerabilities, and that higher priority investment infrastructure initiatives took precedence over CSPO.

In highlighting the necessity of multiple pilots, ALPA reiterated the benefits of a dual role flight crew that fostered division of tasks in addition to backing one another up. This is most especially poignant when responding to emergent scenarios or off-nominal events. In addition, ALPA (2019) referenced a number of FAA and NASA studies wherein increased exposure to risk resulted if further crew reductions took place. What is more, the literature called attention to the limitations in and cybersecurity surrounding remote ground operations. Finally, the Association added the challenges with non-face to face communications between an onboard Captain and a remote FO (ALPA, 2019).

When outlining the risks associated with CSPO, ALPA stated that remote pilot's ability to assist onboard Captains in dealing with both normal and emergent scenarios, resulted in increased workloads and increased risks to the flight. In addition, the paper outlined how a remote FO would have difficulty in responding to multiple monitored flights and might be challenged to compartmentalize the status of each monitored flight, thereby increasing risk exposure. Furthermore, ALPA's position maintained that the NAS' primary design resides around supporting a two-pilot flight deck that can facilitate flights containing dual-pilot capabilities. Finally, in driving home justifications for maintaining a two-pilot flight deck, ALPA stated that a multi-crewed environment sustained a more secure flight deck (ALPA, 2019).

In addressing regulatory and public opinion regarding CSPO, the Association referenced a series of opinion polls and FAA Advisory Circulars weighing in on potential SPO. Of particular note, the piece outlined the absence of explicit CSPO prohibitions for U.S. Part 121 operators within regulatory language, but rather stressed regulatory opinion not in favor of CSPO. In addition, the paper highlighted the FAA's outright prohibition of UAS carriage of passengers for compensation or hire. This bit of information served as an intriguing revelation considering the FAA's most recent position on that very subject. To this end, the ALPA (2019) position paper holds true, however, in referencing the FAA's May-June 2021 edition of *FAA Safety Briefing,* the magazine stated that it was looking "at Advanced Air Mobility (AAM), the vision for using highly automated aircraft to transport passenger or cargo for hire" (FAA, 2021; pg. 2, More Integration Strategies and Tools). All of that aside, the ALPA (2019) white paper still holds that public opinion still favors two-pilots over one in dealing with an emergency (80%) and that the vast majority (96%) believe that public money would be better served in researching other endeavors outside of CSPO.

While acknowledging the great strides automation has contributed to flight safety thus far, the Association proclaimed that current levels of technology cannot perform to such a degree that warrants removing a pilot from the flight deck in the vision of compensating for that pilot's performance. Furthermore, it posited that where specialized automation can assist in completing certain tasks, the flight environment is more challenging and requires a higher level "general artificial intelligence" for it to be of any use in a CSPO flight environment (ALPA, 2019; pg. 25, Summary: Obstacles to Single-Pilot Operations). What is more, ALPA specifically pointed to one of the conclusions captured by the 2012 NASA Ames study, which was also referenced in the Vu et al (2018) paper, which stated that "...the prospect of adding significant autonomous decision-making on a piloted aircraft is viewed with some degree of concern for the ability of the system to add value without adding risk" (ALPA, 2019. Pg. 13; Frost et al, 2012. Pg. 10-12). Lastly, the paper contended that whatever economic gains that might be realized by removing a pilot from the flight deck would be lost in the costs in technology development, additional infrastructure, aircraft certification and training to familiarize with the new CSPO system (ALPA, 2019).

As part of the final summary on the push back against CSPO, the Association further contended that focusing on removing a pilot from the flight deck served as a distraction in regard to more pressing aviation infrastructure needs. To this end, it acknowledged the challenges the FAA faced in integrating UAS into the NAS and the continued efforts required to sustain the momentum of modernizing the air space construct. To turn attention now to CSPO would be a costly distraction that detracted from further NextGen NAS efforts. In addition, the paper contended that other research and development initiatives warranted closer attention due to greater initial payoffs in efficiency and environmental benefits such as quiet supersonic technology, new aircraft designs that would net fuel savings and cutting-edge technologies that focused on increasing flight safety rather than removing pilots from the flight deck (ALPA, 2019).

NGO Strategic Views & Initiatives

Considering the many research efforts that served to bring tactical value to the air transportation industry, it is important to view these explorations under a wider lens in order to gain a greater appreciation of the strategic view and how these initiatives championed by corporate and NGO entities may influence industry in the near future. While the vast majority of these organizations may not directly affect the day-to-day operations in the U.S. Part 121 air carrier world, these views ultimately influence the long-term trajectory of aviation modernization. Inclusion of this section within an aviation specific research paper proved important due to the gravity these potential changes may have on impacting future flight and public safety.

While the focus of this research approach taken to address the above problem statement relied upon a healthy inventory of prior research papers and articles exploring adaptive automation, autonomous and UAS technology with the potential to influence CSPO before the emergence of SARS-CoV-2, it is the calls for accelerated development and adoption of these and other 4IR technologies, most especially in a post-COVID environment that deserve closer examination. To this end, this research aimed to highlight trends showing how the world after the prevalence of SARS-CoV-2, in tandem with the Great Reset, and other 4IR initiatives under the auspices of stakeholder capitalism and the P3 model, threatens to erode the bulwark of safety checks and balances the FAA historically provided by accelerating the merging of humanity with automation all in the name of safety, productivity and efficiency. As outlined in the ALPA (2019) white paper, the views that these merges will inevitably be used as viable justifications to transition to CSPO in an accelerated timeline further threatens to overwhelm the legacy safety and regulatory frameworks employed for decades by the FAA, as it and its historical predecessor regulatory offices successfully shepherded the first 100 years of the American aviation industry. To this end, it is important to call attention to the wider strategic vision of the 4IR, the Great Reset, and how the COVID-19 situation is being leveraged as the impetus to speed these changes across many business sectors that include the U.S. Part 121 air carrier industry.

4IR Tech & The Airline Industry. While the above research outlined in previous sections highlighted promising performance enhancements in connecting adaptive automation with the human element through the use of the HAT model, it should be noted that all WEF literature identified the entirety of the transportation industry as a prime field ripe for disruption through a furtherance of the complete merging of technology with humanity. To this end, WEF visions imagined how a multitude of business sectors could enjoy greater safety, efficiency, and productivity by leveraging this technology-humanity merge. Some aviation and airline industry specifics brought to light were the enhancement of ATC functions that would increase the efficiency of the NAS ATM framework. Others involved the leveraging of AI and UAS to ultimately change the employment landscape for the aviation industry as a whole, specifically calling out helicopter pilots initially, as the vast majority of rotorcraft operations did not carry passengers, thereby earmarking these activities as easily assimilable by UAS without increasing undue risk. However, this theme subsequently widened to include the autonomous carriage of air cargo and passengers by a multitude of means beyond UAS and rotorcraft (Schwab & Davis, 2018). Claiming that manned aircraft operations carry costs that are "10 to 50 times more expensive" in comparison to their unmanned/autonomous counterparts, Schwab & Davis (2018) grasped at the economic argument as the impetus for the complete transition to UAS flight operations (pg. 150, para. 2, The Upside and Downside of Drones).

Further driving the point home, Schwab & Davis (2018) posit that 75% to 80% of transportation jobs were highlighted as at risk for automation. Whether the remaining percentage of transportation jobs not exposed to automation were those allocated to the Part 121 air cargo and passenger industry was not elaborated (Schwab & Davis, 2018).

Figure 3 below provides the relative positioning of transportation's risk of automation against a selected menu of other industries facing automation risks.

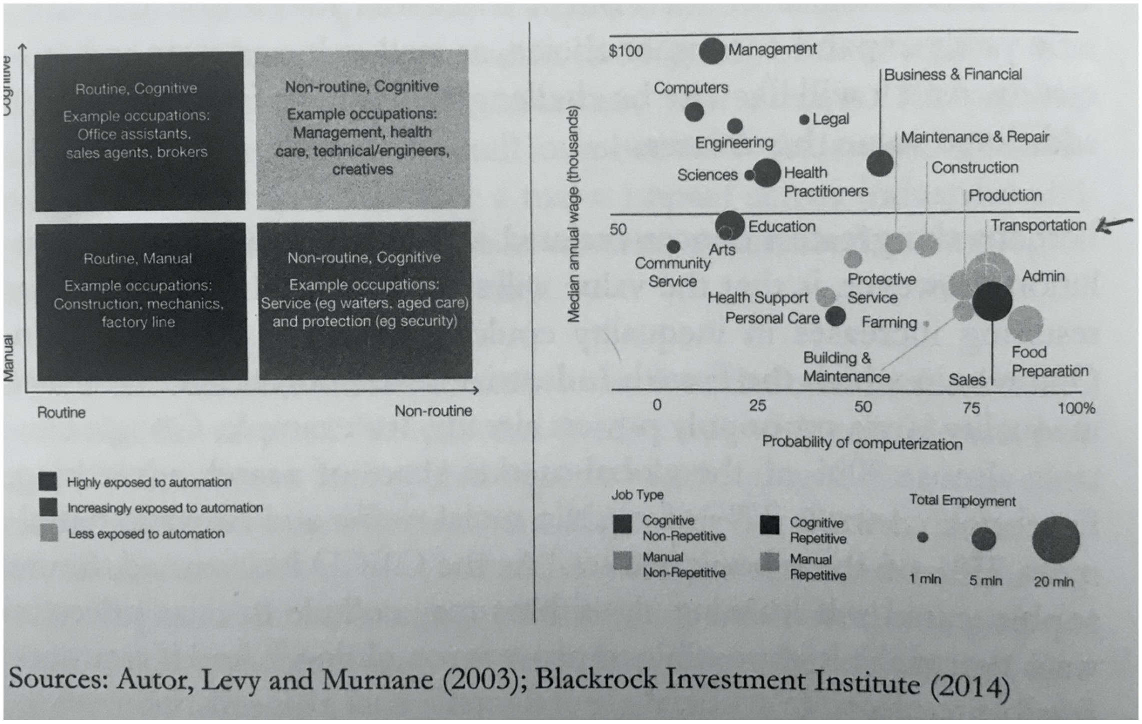

Figure 3. Categories of Jobs at Risk to Automation.

Note: Adapted from Schwab & Davis (2018). Figures 5 and 6: Exposure to Automation of Job Characteristics. Illustrated for Selected Industries, pg. 24.

Merging Humanity with Technology. A recurring theme evident within all WEF literature championed the combining of the physical self with the digital and virtual identities as the path forward towards greater productivity, safety, and efficiency. While discussions of accelerating automation in the workplace appeared regularly throughout all WEF pieces, this strategic vision did not elaborate whether it meant any further merging beyond the HAT concept within an aviation sense. However, specific instances of wearable, hearable, injectable, and even implantable technologies denoted future possibilities of merging 4IR tech with the human element made mention in each of the referenced WEF pieces. These examples did not highlight aviation specific applications per se but were included in the overarching strategic vision of bettering humanity's productivity in industry (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020; WEF, 2020). Most intriguingly of all, in *Adaptive automation and the third pilot,* the study's author recommended that the adaptive automated assistant monitor all aspects of the pilot's experience, physiology, psychology and mental state as part of a comprehensive risk-based decision-making framework (Cahill et al., 2018).

COVID-19: The Great Reset. Most interesting of all, considering the above ideas for integrating 4IR technologies across all facets of society and industry, may be the notion that the COVID-19 situation justified an acceleration of these integrations for citizens and business the world over. To this end, it is extremely important to understand what the implications of these views hold for the aviation industry, more specifically passenger safety when considering the adaptive automation and CSPO research that coincided under the same publishing timelines as the WEF literature from 2016 through to today. In a post-pandemic world, the WEF is championing the idea that the merging of 4IR technology is necessary to emerge from this situation due to the stark differences between the pre-pandemic and post-COVID worlds. To further stress the analogy, consider that, at the height of the unfolding SARS-CoV-2 pandemic, Schwab & Malleret (2020) posited that as "the pandemic [continued] to worsen globally...many [were] pondering when things [would] return to normal. The short response is: never" (Pg. 11, Introduction). Furthermore, they state that "[at] the very least, as we will argue, the pandemic will accelerate systemic changes that were already apparent prior to the crisis: [...] the acceleration of automation, concerns about heightened surveillance[...] the growing power of tech, the necessity for firms to have an even stronger online presence, among many others" (Schwab & Malleret, 2020; pg. 16, Introduction).

Stakeholder Capitalism, P3 & Public Safety Concerns

In addition to addressing how the implications of accelerating 4IR initiatives in a post-COVID world would have on the Part 121 air carrier industry, this section highlights some concerns that some members of the public at large have regarding the acknowledgement of public safety and public interests when viewed in the totality of the wider 4IR vision. To this end, it is easy to see evidence of the P3 model integrating today with regulatory agencies such as the FAA, and how a few examples of how the P3 model functioned in the distant past when other flight safety concerns were brought to the fore. In harkening to a distant past example, most notably the contested disagreements between pilot's unions and airlines on whether the pilot crew standards for the then modern Boeing 737, 767, and 757 aircraft should stand at three or two pilots, a forerunner to the P3 model successfully leveraged to settle the issue (Fadden et al., 2015). In *Evolution of the 2-person crew jet transport flight deck*, the authors highlighted how it took the collaborative efforts of Boeing, the FAA, NASA, and industry stakeholders to successfully make the 2-pilot flight deck a reality (Fadden et al., 2015).

Returning focus to today's concerns regarding the P3 model and 4IR initiatives, it is important to see how this is being implemented and whether public safety is truly at stake. Much like the thoughts shared by ALPA and of the traveling public regarding CSPO and autonomous transport of passengers, it should be concerning that the P3 model is being touted as the solution to a myriad of governmental and regulatory obstacles seemingly stymieing technological progress within this subject of research (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020; WEF, 2020).

Implications of Stakeholder Capitalism & P3. Much like the debacle that came with the certification of the Boeing 737 MAX, one must ask where to draw the line between delegating government regulatory responsibility and aviation industry self-policing (Langewiesche, 2019). While the WEF's P3 model stops short of addressing industry self-certification, it leaves many questions unanswered as to how best address public concerns regarding safety and regulatory responsibility (Schwab, 2018). Considering the FAA no stranger to the P3 model, it is interesting to note an example of how the regulatory agency addressed one question, UAS integration, by using the P3 model as a guide.

In the May-June 2021 issue of *FAA safety briefing,* Flight Standards Service Executive Director, Mr. Rick Domingo, highlighted the methodical approach the FAA took while working in tandem with the UAS industry to safely integrate drones and other UAS platforms into the NAS:

"Through the experienced gained under these rules, also through *several innovative partnerships* [author's emphasis added] between the FAA and aviation community partners, we collectively learned a lot about which questions to ask. We also started to formulate a few answers and, as noted above, we have used this knowledge to add a few more building blocks to the regulatory structure for UAS. The Remote ID rule provides a safety and security foundation for more complex drone operations. The amended part 107 rule allows operators of small drones to fly over people and at night under certain conditions" (FAA, 2021; pg. 2, Utility, Accessibility, Safety).

Considering the above UAS integration example, and the views of the WEF, it appears the P3 model worked as intended. However, questions remain regarding the acceleration of these efforts in a post-COVID world. While the May-June 2021 issue of *FAA safety briefing* does mention the carriage of passengers or cargo for hire using "highly automated aircraft" as part of the overarching Advanced Air Mobility vision, it made no mention as to accelerated timelines given its post-pandemic publishing date (FAA, 2021; pg. 2, More Integration Strategies and Tools).

Privacy Protections & Legacy Regulatory Frameworks. In the views of the WEF and associated sample of established literature outlining the 4IR, it proved abundantly evident that a shift of mental views addressing privacy and data protection needed to occur in order to more fully embrace the greatest potential heralded by 4IR technologies. Most interestingly, every single WEF related piece of literature highlighted privacy protection as main obstacle to fully realizing the complete benefits of merging the physical, with the digital and biological realms (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020). While understandably acknowledging that privacy is not explicitly mentioned as part of the FAA's regulatory mandate, aviation safety is, in addition to fostering new aviation technologies, thereby placing this organization at a dichotomy should technological paths merge the human element with cutting edge automation that have CSPO in mind (FAA, 2016). This is even more poignant when privacy and safety are pitted one against the other when considering questions of flight safety.

To further drive the point home regarding the leveraging of the P3 model in regulatory decision making and upholding privacy or data protections, the WEF's Klaus Schwab offered up an illuminating insight as to what the future may hold:

"The risks and opportunities in leveraging big data for decision making are significant. Establishing trust in the data and algorithms to make decisions will be vital. Citizen concerns over privacy and establishing accountability in business and legal structures will require adjustments in thinking, as well as clear guidelines for use in preventing profiling and unanticipated consequences" (Schwab, 2017; pg. 144, para. 3, Shift 11: Big Data for Decisions).

Solutions to Regulatory Barriers. The WEF's recommended negotiating tool of choice when confronted with these perceived regulatory hurdles hindering the integration to 4IR technology comes in the form of the stakeholder capitalism and the P3 models. So emphatic is this model to the WEF that it is mentioned no less than thirty-six occasions across the sampled WEF literature. While neither of the P3 or stakeholder capitalism models in and of themselves are not a problem in deriving solutions to relevant aviation industry problems, such as demonstrated by the building block approach championed by the FAA and UAS industry (FAA, 2021), unanswered questions remain when examining these models and potential consequences of CSPO, transportation automation, and the merging of humanity with technology under the auspices of the post-COVID acceleration (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020). While published at a time pre-dating the SARS-CoV-2 pandemic by a few months, the ALPA (2019) white paper presciently understood this concern to such a degree that it ardently argued against both the implementation of CSPO within the Part 121 air carrier industry and any form of passenger carriage by autonomous UAS platforms. The submission of the ALPA (2019) position paper could not have been timelier when juxtaposed next to the FAA's May-June 2021 edition of *FAA safety briefing*. In this particular edition of the regulatory agency's bi-monthly publication, the magazine's authors noted the recent announcement from United Airlines beginning research of the use of electric vertical takeoff and landing vehicles (eVTOL) for the purpose of transporting passengers to and from United hub locations (FAA, 2021). Elsewhere in the *FAA safety briefing* edition, further revelations served as yet another example of the P3 model in action, wherein the FAA, NASA, and California-based eVTOL company, Joby Aviation, teamed up to lay the cornerstones towards certification for future commercial operations (FAA, 2021). Despite ALPA's vocal concerns regarding CSPO and, in this particular case, passenger carriage for compensation or hire through advanced automated systems, the FAA also proclaimed that "[soon], we will fully realize the potential of Advanced Air Mobility, where a highly automated unmanned aircraft could transport a person or cargo across town or even between cities" (FAA, 2021; pg. 19, Don't Fear the Drone).

Public Discourse vs. Public Perception. Viewing in retrospect the concerns held by ALPA and the recent revelations by the FAA and United Airlines to research eVTOL capabilities, conveys a larger concern for other stakeholders such as concerned citizens or interest groups in voicing counter viewpoints or resistance to trends that may affect public safety. In this regard, it is fair to note that the United Airlines announcement did not explicitly mention autonomous UAS platforms (FAA, 2021). However, using terms such as "highly automated unmanned aircraft" elsewhere in a high visibility regulatory agency outreach publication certainly could imply the near adoption of said capabilities in the near future (FAA, 2021; pg. 19, Don't Fear the Drone). While some sections of the public may perceive what is unfolding within the 4IR, despite all the talk of empowered citizens, there is not much space in which other segments of gravely concerned citizens not part of established lobbying groups can maneuver to outright halt or stop some or all of the disturbing developments of the revolution affecting questions of citizen safety (Winter Oak, n.d.). This is most significant when leveraging the benefit of 20/20 hindsight and looking through the lens of the recent past while acknowledging the concerns conveyed by the Air Line Pilots Association, yet these 4IR developments continued over the warnings of one of the worlds most respected pilot's unions that brought counter-arguments backed by science and the well-respected NASA organization (ALPA, 2019).

Part 121 Air Cargo Implications

Taking into consideration all the testing and efforts underway at integrating UAS as part of the last mile delivery service essential to a larger logistical chain, it seems natural that Part 121 air cargo operations become the next logical step as part of a larger 4IR transition plan (Deloison et al., 2020). Indeed, the number of key aviation industry stakeholders serving on various WEF agenda steering committees includes transport category aircraft manufacturers, defense companies specializing in both manned and autonomous military air vehicles, cutting edge avionics developers, and even Part 121 air cargo operators (Deloison et al., 2020; WEF, 2020). Given the proliferation of urban UAS integration research as part of the FAA's wider AAM initiatives and the WEF's P3 working group studying last mile implementation plans, it seems only natural that all the research into adaptive automation and CSPO would focus initial efforts into the Part 121 air cargo industry in conjunction with the urban last mile initiatives recently underway in early 2020 (Deloison et al., 2020; WEF, 2020; FAA, 2021). Starting with the wider strategic context of influential research already reviewed, this section delves into the connections between UAS last mile and CSPO research efforts potentially affecting Part 121 air cargo operations.

Resetting the Future of Work Agenda. In acknowledging the potential implications affecting the Part 121 air cargo industry, it is worth exploring these overarching technologies and strategic initiatives earmarked for industrial implementation while also noting the presence of certain corporate entities representing the aerospace industry serving on the WEF's *Preparing for the Future of Work Industry Accelerators* Task Force. Most notably, companies such as Airbus, BAE Systems, Embraer, Gulfstream Aerospace, Lockheed Martin, and The Boeing Company, among others, took active participation as industry stakeholders steering the trajectory of this P3 working group (WEF, 2020; pg. 28, Resetting the Future of Work Agenda). While the WEF's (2020) *Resetting the Future of Work Agenda* white paper focused the majority of potential future changes to office work environments, these are some of the telling clues as to how these strategic visions apply to an aviation industrial environment as well.

Flight Testing of CSPO Tech. Very recently, world-renowned freight company Federal Express (FedEx) quietly teamed up with Lockheed Martin's Sikorsky Helicopters to test CSPO technology on a modified ATR-42 turboprop aircraft sporting FedEx logos and livery. The combination of a corporate freight entity whose aircraft inventory comprising of entirely fixed wing platforms with an aircraft manufacturer more well known in the military rotary wing field might seem peculiar at first, however, it was not the airframe expertise that FedEx was ultimately interested in, but the special MATRIX automation technology Sikorsky began testing on an S-76 helicopter back in 2013 and ultimately unveiled in 2019. This peculiar relationship gained further focus and seemed further cemented when a Cessna 208 Caravan, a common aircraft model leveraged by FedEx as part of its freight feeder network, appeared in a DARPA and Sikorsky autonomous flight test trial decorated in a paint scheme eerily similar to those found on FedEx's inventory of 208's. However, this coincidence lacked veracity due to the fact that the aircraft's registration number was purposely blotted out from view, which prevented any clues as to whom might be the aircraft's owners (Ostrower, 2021). However, in an August 2020 piece published by Flight Global, it proved overtly apparent that FedEx partnered with a Silicon Valley startup named Reliable Robotics to explore autonomous aircraft capabilities in both Cessna 172 and Cessna 208 aircraft. In this regard, not only was there photographic evidence of the FedEx Caravan on display, but it also specifically called out the aircraft owners as FedEx as having took part in this test (Hemmerdinger, 2020). Previous to these most recent developments between FedEx, Sikorsky, and Silicon Valley startups taking place in both East and West Coast airport locales, the freight carrier expressed interest in CSPO and autonomous flight capabilities in conjunction with a New England based startup company M2C Aerospace as far back as October 2018 wherein the organization began simulator and flight tests with a multi-engine ATR turboprop aircraft in the air cargo configuration in Antigua (Bachman, 2018).

Optionally Piloted Aircraft Examples. In order to provide perspective and context regarding FedEx's collaborative relationship with Sikorsky and their associated explorations into autonomous and CSPO technology tied to the MATRIX system, it may be worth noting some of the cutting-edge designs and research milestone achievements netted by Lockheed Martin in both legacy and Future Vertical Lift military platforms. To this end, Lockheed Martin Sikorsky announced in March 2021 of the first successful integration of the MATRIX autonomous technology into a legacy UH-60A Blackhawk helicopter wherein a successful autonomous test flight was completed with pilots monitoring. This test flight was completed in conjunction with DARPA's Aircrew Labor In-cockpit Automation System (ALIAS) project and focused on reducing pilot workload or facilitating SPO or even fully autonomous flight. While the exact date of the flight was not disclosed, Sikorsky intended those future efforts involving a fully autonomous flight to occur at some point in 2021, in addition to integrating these results into Sikorsky's offerings in the U.S. Army's Future Vertical Lift program (Reim, 2021).

CSPO Timelines for Part 121 Air Cargo. Considering the totality of research, design, test and evaluation of adaptive automation and autonomous flight capabilities, posed questions remain authoritatively unanswered as to how long before adaptive automation facilitating CSPO, or autonomous flight ops will integrate into the Part 121 air cargo realm. While no definitive published timelines exist from either a regulatory agency such as the FAA or from key industry players from the Part 121 world, certain clues from various thought leaders and aerospace industry chiefs presented themselves as an idea as to when to expect such a transition.

In the latter half of 2018, chairman of the U.S. House Science, Space, and Technology Committee, Texas Representative Lamar Smith, inserted a measure into a budget bill funding the FAA that also included language initiating a "research and development program in support of single-piloted cargo aircraft assisted with remote piloting and computer piloting" capabilities (Bachman, 2018; Para. 11). While this language was ultimately stripped from the final version of the bill when it was passed in October 2018, it lent credence as to when serious considerations by legislative and executive branches of government begun serious deliberations for integrating autonomous and CSPO explorations within the regulatory bounds of government (Bachman, 2018). A July 2018 New York Times article by Wichter (2018) outlined Boeing revelations that the company was researching the potential for unmanned commercial flight operations. Not to be outdone, Airbus Chief Commercial Officer Christian Scherer proclaimed in 2019 that there existed no technological barriers to implementing pilotless commercial airliners, just regulatory hurdles, and public perception challenges (Bostock, 2019). Also in 2019, a BBC article described the political, liability and professional resistance of shifting to CSPO, but also contained an opinion from one UBS analyst that thought CSPO could become a reality by 2022, spearheaded by the mental realizations of immense costs savings that could be achieved by shifting to just a single pilot (Nunes, 2019). This, after similar sentiments were shared in a 2018 Bloomberg article, wherein other UBS Group analysts opined that long haul passenger airline crews could see CSPO beginning in 2023, and only then after the Part 121 air cargo segments had long transitioned by then (Bachman, 2018).

Acutely aware of all these developments threatening professional pilot livelihoods and air passenger safety, ALPA International leveraged a study included in their white paper completed by Bryce Space and Technology that contended that technological capabilities supporting CSPO able to meet or exceed equivalent levels of safety stood at least ten-plus years away at the time of publishing (ALPA, 2019; Pg. 21, Fig. 9, A road map of the technologies to develop single-pilot operation). Furthermore, it also referred to other scientific opinions within the position paper that posited that the capabilities of general AI needed to sustain equivalent levels of passenger safety under autonomous flight scenarios stood at twenty years away (ALPA, 2019). Lastly, ALPA reminded its readers of the ongoing overhaul and modernization of the NAS in order to handle the steady growth of passenger air traffic, albeit during a pre-COVID world. Completing all NAS modernization goals between the combined efforts of the FAA and NASA by 2025 would be stymied should attention be focused on flight deck crew reductions (ALPA, 2019).

Public Sentiments & CSPO. Sometimes public reaction and opinions can influence the relative speed at which societal shifts occur. Regarding public preference on CSPO, a number of polls reflected vacillating views on CSPO and autonomous passenger flight depending upon sample demographics. Of particular note, some polls marked a shift in CSPO and autonomous flight support when economics were factored into the equation (Bachman, 2018; Ipsos, 2018).

Published in July 2018, independent market research company Ipsos conducted a poll on behalf of the ALPA International pilot's union of over 1,100 respondents regarding opinions of pilotless airliners. The results of this poll revealed that 81% would not find it comfortable flying aboard a pilotless airliner. However, breaking the results down by demographics, the poll revealed that men and young adults aged 18-to-34 were the largest contingent group who would feel comfortable flying on a pilotless passenger airliner (26% and 28% respectively). Perhaps most interestingly, when considering possible economic benefits due to cost savings from pilotless airliners, the percentage of respondents uncomfortable with autonomous passenger planes dropped to 66% when a 30% ticket price savings was offered (Ipsos, 2018). Finally, Ipsos research findings determined that "more than eight in ten Americans believe that two pilots working together is the best option when it comes to solving problems" such as those found during aircraft emergencies (Ipsos, 2018; pg. 2, Research Findings).

Other pieces highlighting conflicting views amongst the varying demographics were captured in a 2019 Business Insider article that pointed to a newer poll conducted by an American autonomous software firm proclaiming that greater than 70% of Americans were willing to fly aboard a fully autonomous aircraft (Bostock, 2019). Additionally, referencing the same UBS analyst report from previous sections above, it acknowledged passenger acceptance of autonomous airliners as challenging, but went on to illustrate that passenger acceptance of autonomous or single pilot airliners increased by 50% when offered a discounted airfare. To be clear, this same report also noted that 63% of respondents opposed pilotless airliners while 52% opposed CSPO (Bachman, 2018).

Pre- vs. Post-COVID Implications. It should be noted that the above Ipsos (2018) and UBS survey poll results were published at a time when the passenger and air cargo industry were still on the upswing and concerns about perceived illness or pandemic ramifications were very far from the mind of the common air passenger (Bachman, 2018; Ipsos, 2018). Once again leveraging 20/20 hindsight when peering through the historical lens revealed dramatic shifts in travel habits and global perceptions about health and the digital tools available to sustain healthy populations. Nowhere is this technological perception shift more apparent than in the digital 4IR solutions offered in the spirit of keeping passengers safe. In line with the much-touted omens from the WEF's Klaus Schwab, the 4IR technology currently sweeping the globe under the auspices of biosecurity and passenger safety will ultimately lay the groundwork for the subsequent adoption of the aforementioned CSPO and autonomous capabilities dovetailing into the greater air cargo and airline passenger world (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020).

Narrative Shaping & Public Perceptions. As part and parcel of the greater 4IR agenda, using technology to influence passenger sentiments as a role in current initiatives governing health and passenger security may undoubtedly serve the same purpose to assist in shifting public perceptions resistant to CSPO and autonomous airliners (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020). While specifically addressing societal resistance to technological change, Schwab & Davis (2018) denoted that: "[resistance] arises when the attributes of the technologies impinge on societal priorities, and groups push back. If technologies receive a great deal of resistance from the public or from particular stakeholders, examining these areas of opposition can highlight the conflicts between the values of society and those that have become a part of the technologies through their process of development" (Pg. 43, Societal Resistance).

Nowhere is this clearer than the widened philosophical disparity between ALPA and the amazing autonomous achievements realized by industry stakeholders such as FedEx, Lockheed Martin, Sikorsky, and Boeing, among other autonomous technology startup organizations (Hemmerdinger, 2020; Ostrower, 2021). Indeed, Schwab & Davis (2018) further highlighted the continued missed opportunities to address societal concerns at the nascent points of research:

"While investors could engage in the very early stages, it is unfortunately the final inflection point, societal resistance, that is one of the most frequent ways in which regulatory bodies are forced to address values. The very existence of societal resistance suggests that other opportunities to consider broader impact and values in the process of technological development have been missed" (Pg. 44, Societal Resistance).

Taking the latest quote into consideration, it appeared ALPA's white paper paid due diligence to spearhead the conversation regarding concerns about CSPO and autonomous aerial technologies with other stakeholders by utilizing the P3 model, however, progress continues towards these futures in the absence of further meaningful discussions or responses between the stakeholders (ALPA, 2019; Ostrower, 2021). What is more, acknowledging lamentations of Schwab & Davis (2018) about societal resistance and inflection points intercepting at the regulatory level, CSPO & autonomous airliners are notably absent amongst the themes highlighted in the latest May-June 2021 edition of *FAA safety briefing,* which contained discussions pointing to an eventual autonomous passenger carriage for hire industry, but it involved UAS integrating into the NAS not CSPO or autonomous airlines (Schwab & Davis, 2018; FAA, 2021).

Summary

In summary, a review of the relevant literature sections highlighted a rich source of studies and literature that showcased the current state of explorations into CSPO and technology facilitating autonomous flight capabilities. However, there is a lack of comprehensive research connecting these efforts to wider global agenda influenced by sovereign, corporate or NGO interests. Furthermore, highlighting these connections may serve to spearhead further in-depth conversations utilizing the P3 model that benefits society in the interest of preserving flight safety and associated professional livelihoods amidst such drastic technological changes focused on the vital U.S. air transportation system.

To this end, the wide array of literature combined in this chapter proved necessary to draw connections between the tactical research achievements to the wider NGO strategic views implemented through industry and regulatory frameworks. These connections served the purpose to compare and contrast the influencing forces each stakeholder contributed to the industry. Lastly, connecting past research with the latest developments in UAS, autonomous flight, and CSPO technology may illuminate the future changes yet to come affecting the Part 121 air transport industry that is so vital to the American economy.

Chapter III

Methodology

Research Approach

This study leveraged a comprehensive qualitative content analysis and narrative inquiry in reviewing a vast literature array that included books, peer-reviewed studies, journal entries, academic papers, industry public releases and various news articles exploring autonomous flight technologies, CSPO experiments, notable UAS achievements, and regulatory agency outreach publications. The purpose behind this approach served to demonstrate how future flight deck automation capabilities, in conjunction with corporate, sovereign, and other NGO entities, driving toward the 4IR agenda, might influence the Part 121 airline industry employment prospects for today's and tomorrow's aspiring pilots and aircrew. Furthermore, analyzing this vast array of data sources helped to draw parallels between cutting edge research achievements and NGO agendas intended for a globalized impact.

Design and procedures. This study required a comprehensive qualitative review of peer-reviewed journals, studies, and research papers to gain a grasp of the state-of-the-art research capabilities surrounding CSPO and autonomous flight capabilities. Further qualitative analysis included published books, white papers, or articles highlighting strategic initiatives that assisted in telling the research story.

Starting at a wide strategic level, this research reviewed four main pieces of WEF literature highlighting the integration of 4IR technologies across the globe and how it will serve to drastically alter society at the socio-economic and geo-political level (Schwab, 2017). Specific titles included *The fourth industrial revolution* (Schwab, 2017), *Shaping* *the future of the fourth industrial revolution* (Schwab & Davis, 2018), and *COVID-19: The great reset* (Schwab & Malleret, 2020). In addition, insights drawn from the WEF's October 2020 white paper titled *Resetting the future of work agenda: Disruption and renewal in a post-COVID world* (World Economic Forum, 2020) and *The future of the last mile ecosystem* (Deloison et al., 2020) greatly assisted in painting the backdrop in which the future socio-economic environment envisioned by the highest levels of sovereign and corporate governance sustained and bolstered focused research completed at the tactical level exploring potential CSPO and autonomous flight capabilities.

Shifting focus from the strategic level to the granular tactical pilot performance lens, the vast majority of data reviewed here for this project drew from a multitude of previous research exploring changes in human performance in the face of increasingly advanced autopilot capabilities and digitized flight displays (Miller & Holley, 2018). Of particular note, recent research on adaptive automation systems and explorations into human physiology measurement systems by automated machines was leveraged (Arico et al, 2016). In addition, referencing UAS performance milestones to include unique remote piloting and autonomous performance achievements proved helpful in determining past and current technological states of the art (Astrea, 2013; Szondy, 2018). Other sources of data include articles on single pilot research for air cargo operations and explorations into autonomous passenger transport (DiVito et al, 2021). Most notably, highlights in recent achievements of ATTOL of large transport category aircraft were referenced (Airbus, 2020).

While completing the research and explorations of both strategic visions and tactical research accomplishments, this research drew out the trends and compared all of them through a pro versus cons analysis and how it affects future Part 121 professional pilot employment prospects. While not the main focus of the research paper, safety and cost will also be weighed as part and parcel of the pilot employment pro versus con implications. Findings and implications of the pro versus con analysis are included in the results section of this paper, in addition to their influencing factors to the conclusions and recommendations.

In order to foster a greater understanding of future implications of the above research, a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis helped in understanding a comprehensive view of how 4IR technologies, stakeholder capitalism frameworks, and the continued evolutions of public regulatory architectures towards expanding P3 models influenced the integration of advanced technologies ultimately destined to speed the implementation of viable CSPO frameworks. In addition, the employment of the SWOT analysis tool assisted in highlighting past and current decision-making trends that showed key research and events facilitating concrete steps towards the evolution of a CSPO environment. Furthermore, a Political, Economic, Societal, and Technological (PEST) analysis was added to further highlight the strategic implications of CSPO and autonomous flight capabilities facilitated by NGO agendas fostering research in these areas.

Apparatus and materials. This project used Microsoft Excel as the platform to code for certain literature themes within selected published books. This method assisted in easy recall of reviewed highlights in hardback or paperback literature sources. Otherwise, Adobe Portable Document Format (PDF) served as the sole platform for reviewing digital literature due to the *Advanced Search* function facilitating near immediate coding and organizing of certain literature themes across a vast array of digital libraries, which greatly enhanced research efficiency.

Sample

There are no quantitative samples for this study due to the qualitative nature of the exploration. The only source of relatively close numerical value may lie in the quantification of key words and definitions captured in the MS Excel file reviewing some of the WEF literature for codes and themes. In this regard, the purpose of this file was to better assist in finding certain themes in the hardback/paperback books for easy reference at any time. Otherwise, quantitative references allude to those pieces of information published within the qualitative sampling of literature. The author did not conduct any polls or quantitative calculations whatsoever.

Sources of the Data

Initial data sources for this study included published books from the World Economic Forum and other literature highlighting 4IR visions such as agenda studies and white papers. The inclusion of these documents was for the purpose of drawing out strategic influences affecting the global aviation industry from a timeline starting from 2016 onward. In addition, research pieces such as peer-reviewed studies and journals on adaptive automation, flight deck designs and human cognitive abilities and limitations were referenced from the ERAU Hunt Digital Library. Furthermore, regulatory agency outreach publications assisted in providing situational awareness as to the latest developments within aviation regulatory circles. Lastly, any news articles denoting state of the industry and aerospace manufacturer public releases regarding the showcasing or testing of cutting-edge technology or research approaches supporting CSPO and autonomous flight capability milestones were included for edification purposes.

Validity

The data collected for this study is assumed to be reliable and valid as it is from various peer-reviewed journals and studies. These journals and studies often were contributed to by other U.S. government agencies and major universities with keen interest in the global aviation industry, cognitive computing, brain-based devices, and adaptive automation. With regards to the other literature pieces such as books or white papers, these are presumed valid on account of the wide audience and membership commanded by these world-renowned organizations.

Treatment of the Data

The array of literature and studies were reviewed and qualitatively coded to highlight trends and insights for easy recall. For some literature pieces unable to be searched or recalled electronically via Adobe Portable Document Format (PDF), certain words or phrases relevant to certain WEF themes were captured in an MS Excel spreadsheet for easy recall and accountability. Otherwise, the remaining studies and journal entries were referenced and highlighted to draw attention to those themes most relevant to the topic at hand.

Highlighting and categorizing the various insights and themes assisted in drawing numerous comparisons and contrasts across the literature, in addition to pointing out poignant consistencies. Some of these data points were captured in visual charts or tables that assist the reader in drawing conclusions or interpretations. These tables and figures include pros vs. cons, SWOT & PEST Analyses, timelines of notable UAS accomplishments, changes to flight crew standards and strategic maps.

Chapter IV

Results

Major Themes & Patterns

The major themes and patterns from the above literature review denoted a consistent trend of technological advancement that delivered perpetual impacts affecting the roles humans play in the world of aviation. These advancements included improved aircraft systems reliability, improved aircraft performance, improved automation systems that ultimately decreased workloads, but ultimately burdened human pilot cognitive performance. The vast majority of these improvements stood to change flight deck crew make ups for decades after the jet-age while other improvements brought sweeping capabilities to the UAS field. Furthermore, these refinements spurred innovation and research into machine learning and AI, which affected the research, design, test and evaluations of CSPO and autonomous flight capabilities earmarked for air cargo and airline industry adoption. These potential changes bring with them a host of other second and third order societal effects that may not be fully realized yet.

Changes in Flight Deck Crew Standards. The below figure provides a brief overview of the highlighted changes to required aircrew members on aircraft more commonly used for transport of passengers or air cargo. Essential to highlight is the elapsed time between acknowledged changes when flight crews started out at five in number, then decreased to three and then just the two pilots. Note the roughly thirty-year time spread between changes to flight crew levels in the past, and the current elapsed forty-year time span of the currently existing two-pilot flight deck standard.

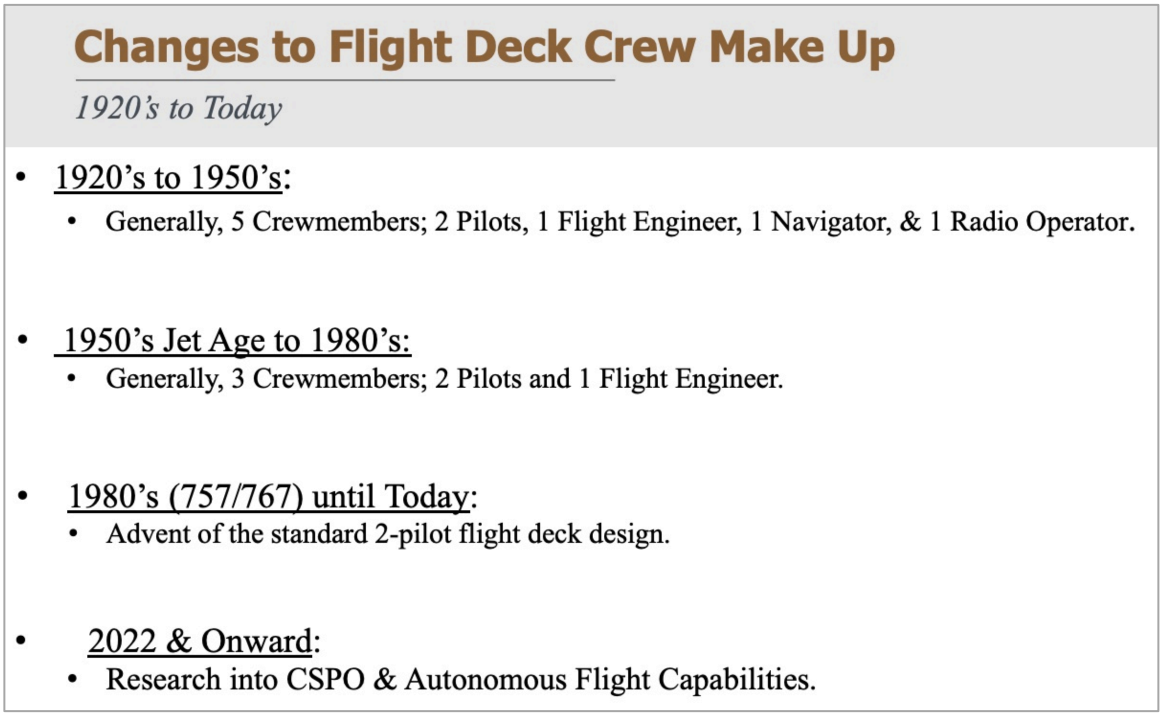

Figure 4. Summary of Changes in Flight Deck Crew Standards (Fadden et al., 2015).

Notable UAS & RPA Accomplishments. The technology that facilitated notable UAS accomplishments highlighted in the literature review resulted in a number of firsts within the field. In addition, the elapsed time between major achievements narrowed resulting in a seeming acceleration of UAS capabilities and new discoveries. The timeline captured in *Figure 5* below supports this as the number of illustrated milestones gets more concentrated the further time progresses towards the present. It should be noted that not all historical UAS firsts were referenced for this project, just those noteworthy and backed by verifiable references were considered. In addition, also note that the further technology advanced, the blurring of lines between UAS capability and CSPO and autonomous flight capability becomes blurred.

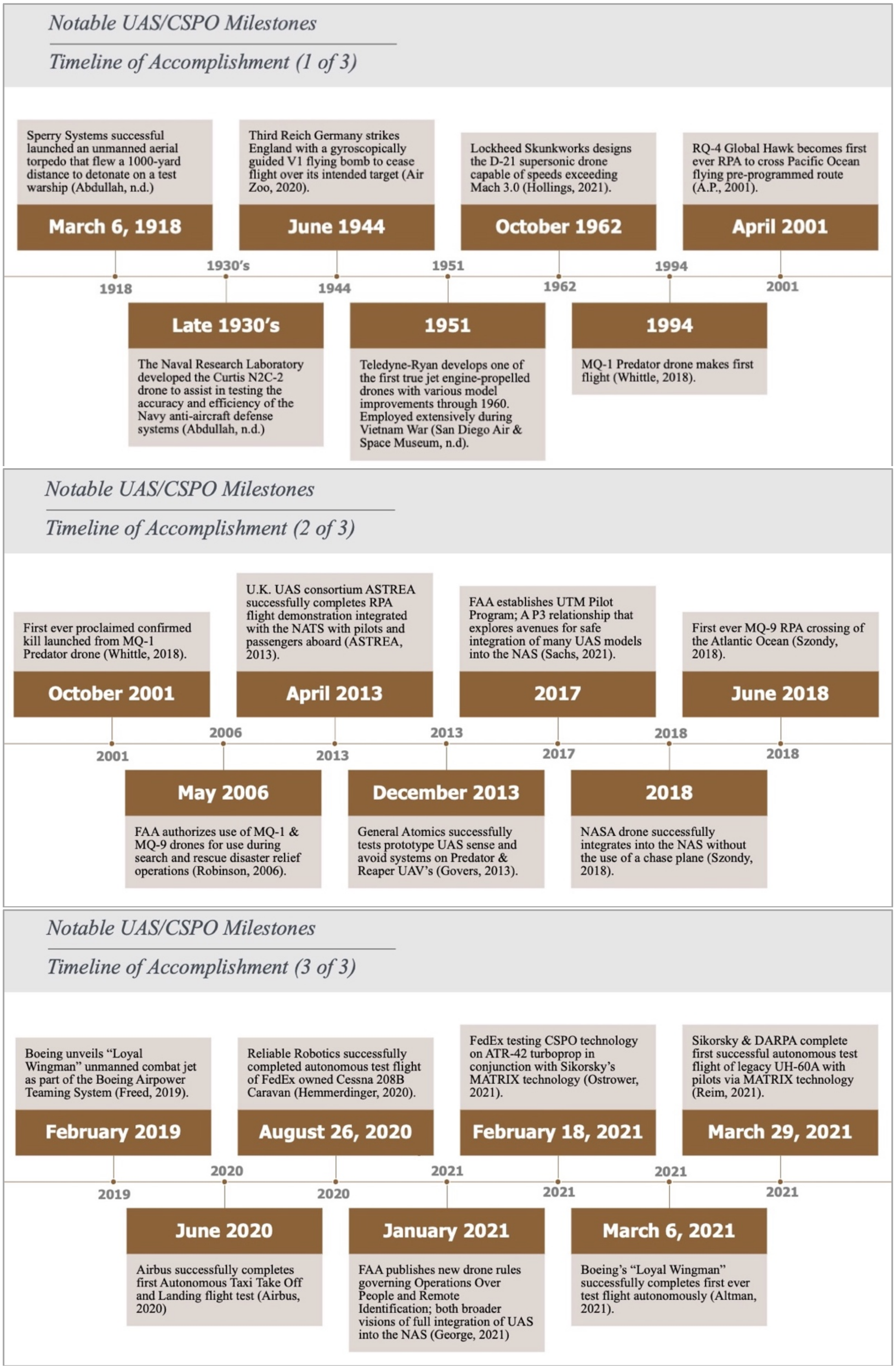

Figure 5. Notable UAS/CSPO Milestones.

CSPO Pros vs. Cons. The challenge in generating a pro versus con chart to capture relevant concerns surrounding CSPO served as a double-edged sword in some regards that each seeming pro (or con) had a resulting con (or pro) or vice versa. In order to capture all sides of the argument, both viewpoints were listed to provide a comprehensive look into the impacts CSPO may have on the Part 121 aviation industry. A common thread between the research studies exploring CSPO and the ALPA (2019) white paper against CSPO highlighted seeming economic savings as the impetus behind switching to a CSPO framework. In addition, both references also mentioned the possible requirement of the use of ground-based remote FO's for safety purposes as effectively nullifying this economic benefit (ALPA, 2019; Vu et al. 2018).

Commercial Single Pilot Operations (CSPO)

PROS	*versus*	*CONS*
• Economic cost savings by reduced crew member requirements. • Lower ticket prices offered to air travelers. • Streamlined crew duty scheduling. • Offset scheduling challenges due to "pilot shortages." • Leveraging adaptive automation architectures that reduces pilot workload. • Less pilot error. • Smoother aircraft operation through all phases of flight.		• Loss of cost savings due to employment of ground-based Remote FO's. • Realized savings only occur when ground-based Remote FO's manage more than a single flight. • Research highlighting Remote FO loss of situational awareness of other managed flights when assisting airborne Captains in need. • Ipsos (2018) polling data suggesting only deep airfare discounts would spur passenger demand to board CSPO planes. • Nebulous CSPO regulatory safety and performance requirements. • Unknown CSPO aircraft certification requirements/guidelines. • New cybersecurity vulnerabilities due to required ground-based aircraft control/communications frameworks. • Automation always fails. • No second pilot to serve as backup.

Figure 6. Summary of CSPO Pros vs. Cons.

CSPO SWOT Analysis. The general purpose of a SWOT analysis assists business entities in assessing strengths, weaknesses, opportunities, and threats for a given market niche. However, for the purpose of this project, the SWOT analysis template proved helpful in illustrating the integration of the CSPO concept within an industry, in this case, the Part 121 scheduled air cargo and airline passenger market. While somewhat similar to a pro versus cons laydown, the below SWOT analysis contained in *Figure 7*, widened the scope of view and considered how different aspects of the cons side applied to the potential integration of CSPO on the aviation industry. Of particular note, second order effects tied to potential professional pilot job loss was captured under the threats section on account of societal resistance stemming from the realized loss of such a prestigious profession. Justifications for this view might derive from the high cost, in both time, money, and experience to break into such a high barrier profession (ALPA, 2019).

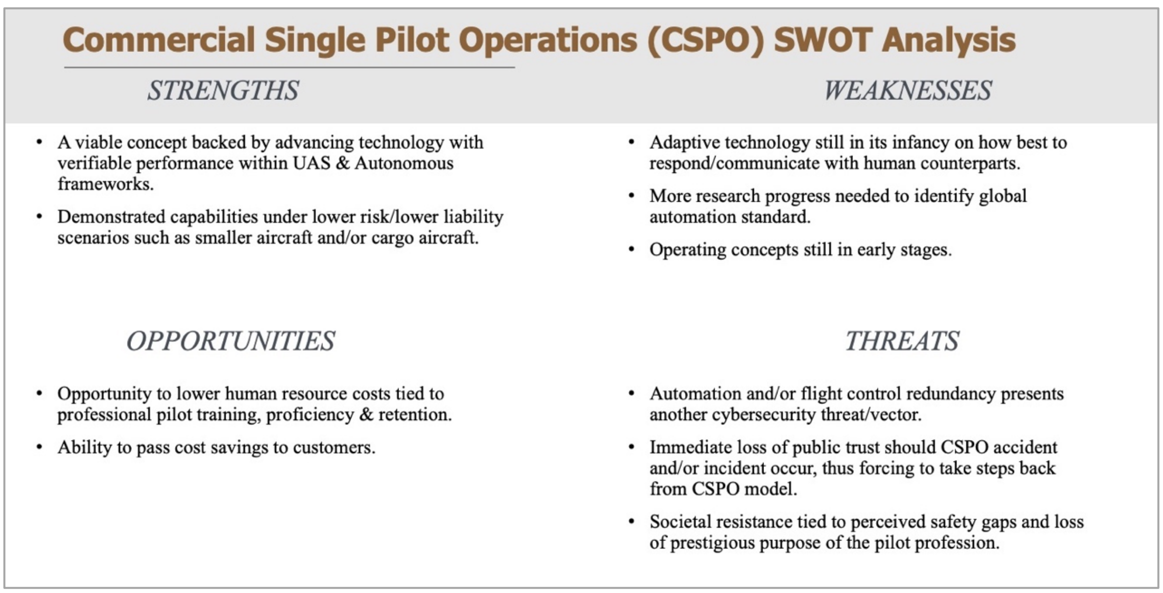

Figure 7. CSPO SWOT Analysis.

CSPO PEST Analysis. In order to better understand the overarching societal impacts stemming from the WEF's Great Reset and other post-COVID related changes, a Political, Economic, Societal and Technological (PEST) analysis was added to the project. This analysis assisted in converging the paralleling threads between the above influences with the aviation implications related to CSPO and autonomous flight capabilities research. Furthermore, additional figures referenced from the WEF's *Strategic Intelligence Map* leveraging a visual display of how each strategic vision influences various industries were included for those threads that applied to aviation (World Economic Forum, n.d.). *Figure 8* below contains a concise PEST analysis highlighting a few of the recurring themes captured in the above literature review. Inclusion of the PEST analysis delivered a broader view over the previous pro versus con and SWOT analyses. What is more, this analysis may prove helpful in understanding the potential implications of certain stakeholder groups being left out or excluded from the P3 discussion **(**Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020)**.**

Commercial Single Pilot Operations (CSPO) PEST Analysis

POLITICAL

- Potential U.S. Congressional action spearheading CSPO/Autonomous flight capability studies tied to agency funding.
- Industry lobbyists, trade associations, and interest groups engaging for or against CSPO & autonomous flight capabilities.
- Political influences filtering down to executive level administration and regulatory agencies (i.e., FAA, NASA).

ECONOMIC

- Perceived airline corporate cost savings through human resource reductions (i.e., less pilots).
- Unknown costs tied to CSPO implementation (i.e., technological frameworks, safety, system redundancies).
- Questionable airfare reductions for airline customers; dependent upon airline savings.

SOCIETAL

- Concerns tied to CSPO driven job losses.
- Lack of skills restructuring opportunities (i.e., reskilling/upskilling)
- Public resistance due to safety concerns.
- Public resistance due to loss of voice and/or lack of stakeholdership.
- Perceived airline profits over people due to safety concerns tied to CSPO.

TECHNOLOGICAL

- Automation and/or flight control redundancy presents another cybersecurity threat/vector.
- Artificial General Intelligence (AGI) still in its infancy/unable to match intellect required to serve as a viable aircrew member.
- Demonstrated adaptive automation ability to reliably respond/communicate with human pilots still unproven.
- Regulatory efforts focused on NAS technological modernizations, not flight deck optimizations purposed for CSPO.

Figure 8. CSPO PEST Analysis.

WEF Great Reset Strategic Intelligence Map. Located at the World Economic Forum's (n.d.) webpage outlining a myriad of subjects regarding discussions on how to best integrate strategic initiatives across a multitude of societal and business sectors is a graphic that maps out many lines of seemingly disparate entities and connects them all in an intricate fashion to such a degree that it illustrates all spheres of influence playing a role in the WEF's Great Reset plan. To this end, and to capture illuminating information relevant to this project, the author inserted illustrative examples of the Great Reset *Strategic Intelligence Map* as *Figures 9, 10, 11,* and *12.* It has been said that pictures are worth a thousand words (Terrar, 2014). In this case, the WEF outdid the design and delivery of the *Strategic Intelligence Map* as it conveys an exacting and overarching review of the very sectors planned for influence (WEF, n.d.).

Beginning with *Figure 9,* the Aerospace sector map shows relationships to various other entities seemingly connected or part of the Great Reset agenda. Of note, the map addresses Aerospace and Aerospace's Digital Age and connected to it are a number of supporting spheres of influence. In this regard, those highlighted for transition include Future of Mobility, Cybersecurity, Digital Communications, Internet of Things, Internet Governance, Digital Economy and New Value Creation, and Fourth Industrial Revolution (WEF, n.d.). This list should come as no surprise considering the ALPA (2019) white paper that denoted new risk vectors tied to CSPO or autonomous flight capabilities stemming from the cybersecurity and communications integrity concerns to sustain such operations. What is more, in the May-June 2021 edition of *FAA safety briefing,* it specifically pointed to continuing progress the regulatory agency made in working with industry to continue the "building block" approach in laying the Advanced Air Mobility (AAM) foundation, which included the full integration of UAS into the NAS, in addition to those earmarked for autonomous carriage of passengers for hire (FAA, 2020; pg. 2, Utility, Accessibility, Safety).

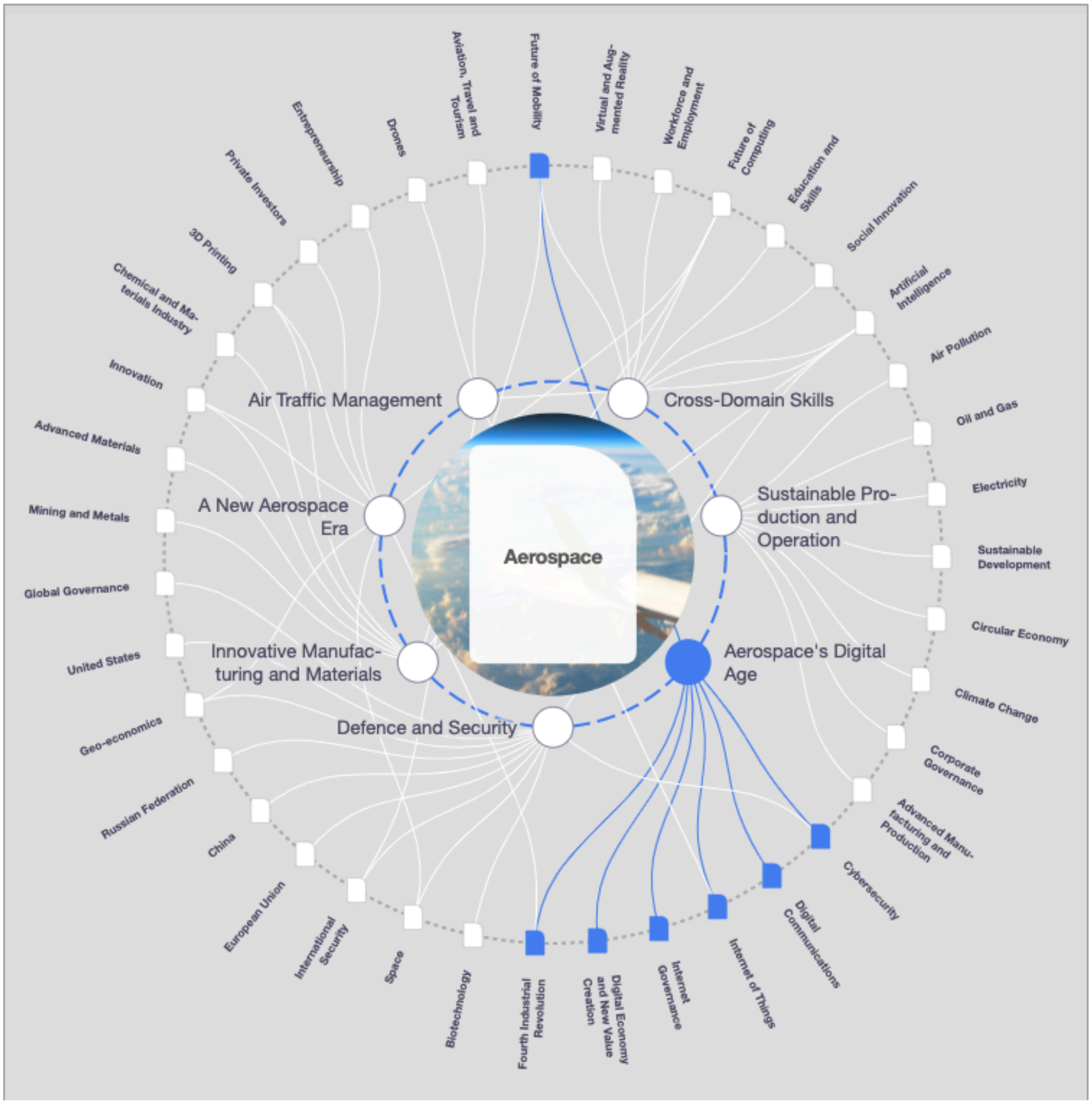

Figure 9. WEF Great Reset Strategic Intelligence Map – Aerospace – Aerospace's Digital Age (WEF, n.d.).

Reviewing *Figure 10,* Aerospace and Air Traffic Management, identified spheres of influence include Drones, Aviation, Travel and Tourism, Artificial Intelligence, Internet of Things, and International Security (WEF, n.d.). Once again, the ALPA (2019) position paper addressed UAS, AI, and the security risks tied to required communications (digital data and voice) sustaining CSPO and autonomous flight operations. The same holds true for the FAA's outreach publication released in May-June 2021 (FAA, 2021).

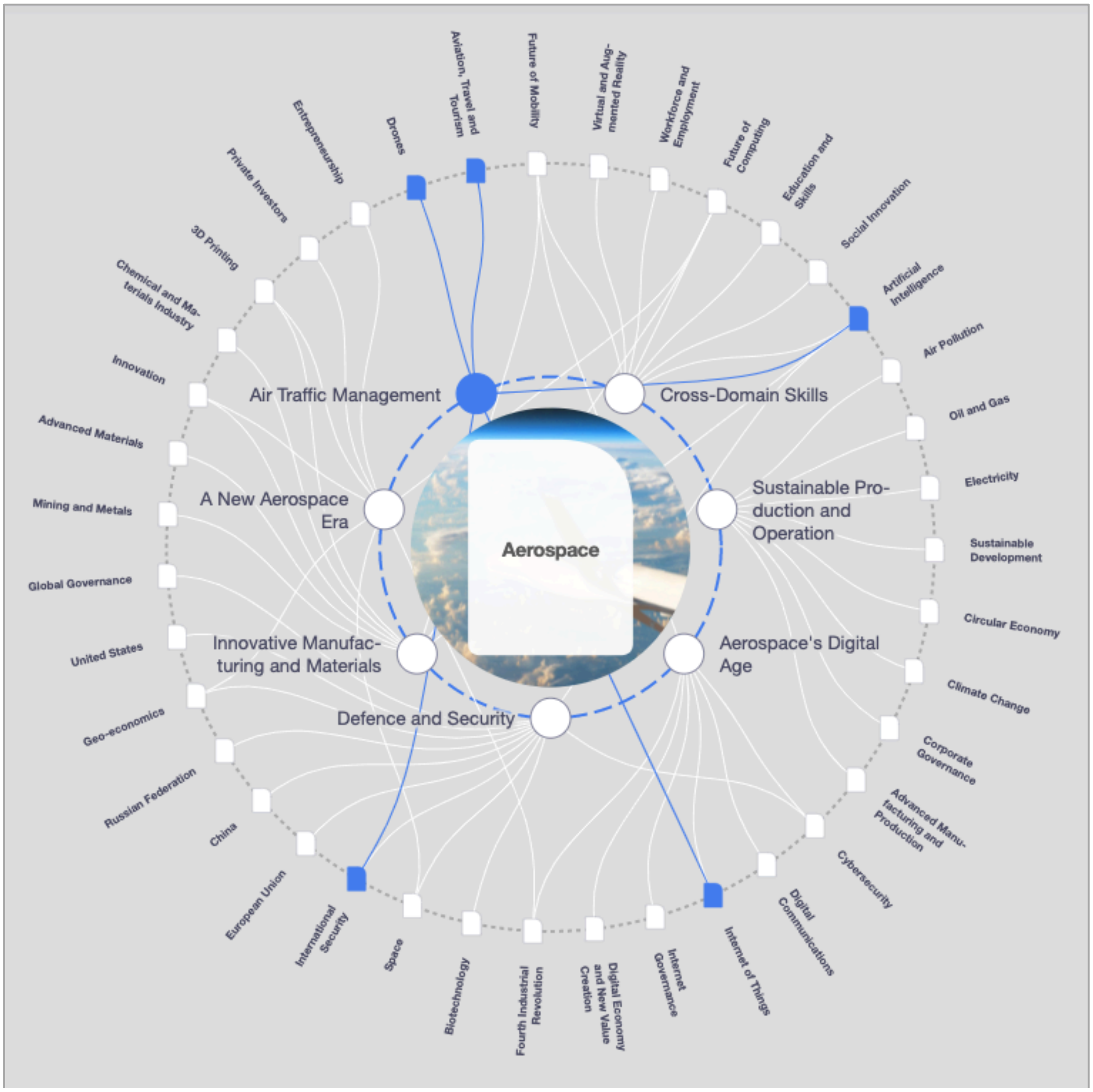

Figure 10. WEF Great Reset Strategic Intelligence Map – Aerospace - Air Traffic Management (WEF, n.d.).

Turning attention to *Figure 11,* Drones, common threads previously acknowledged present themselves yet again such as Fourth Industrial Revolution, Artificial Intelligence, Internet of Things, Aerospace, Aviation, Travel and Tourism. New additions to the sphere include Blockchain, Global Governance, Innovation, 5G, Supply Chain, and Transportation. This is the first time Infrastructure and Aerospace were connected under this thread, perhaps acknowledging the autonomous nature of

Drones and their necessary infrastructure to support them and other autonomous endeavors tied to the FAA's AAM framework (WEF, n.d.; FAA, 2021).

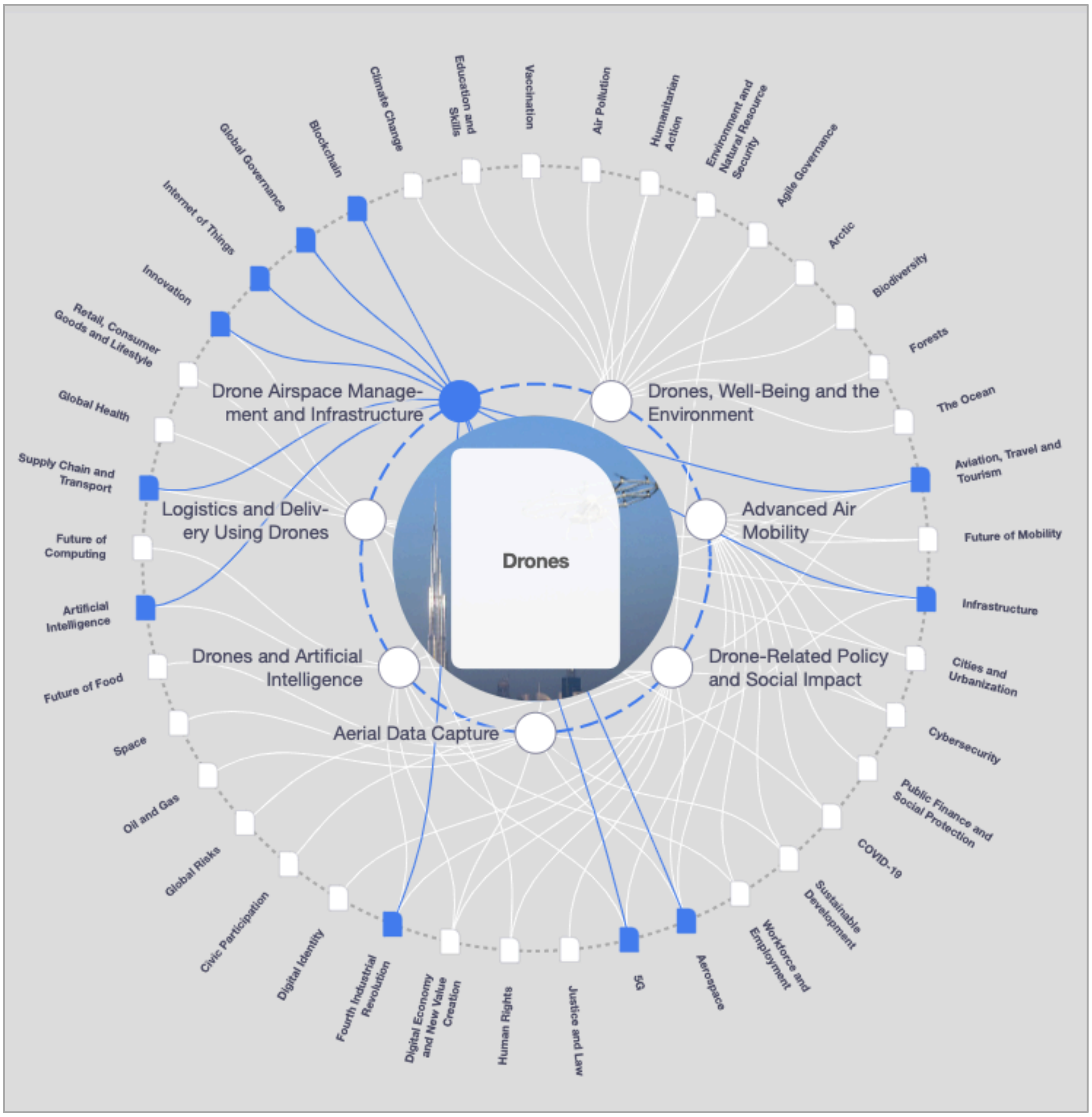

Figure 11. WEF Great Reset Strategic Intelligence Map – Drones (WEF, n.d.).

Last is *Figure 12*, which addresses AI and its respective purposes. Specific themes to aviation within the context of AI included International Security, Global Risks, Agile Governance, Global Governance, Corporate Governance, Future of Mobility, Science and Education and Skills. While very strategic in nature, each of these spheres of influence applies to the specific aviation implications tied to CSPO and autonomous flight capabilities by AI's utility as the essence of transition to a seemingly pilotless future. The very fact that ALPA (2019) noted AI and its present-day shortcomings in replacing a human pilot further underscores the importance of bringing it up as part of this project's strategic outline of potential CSPO impacts on the aviation industry.

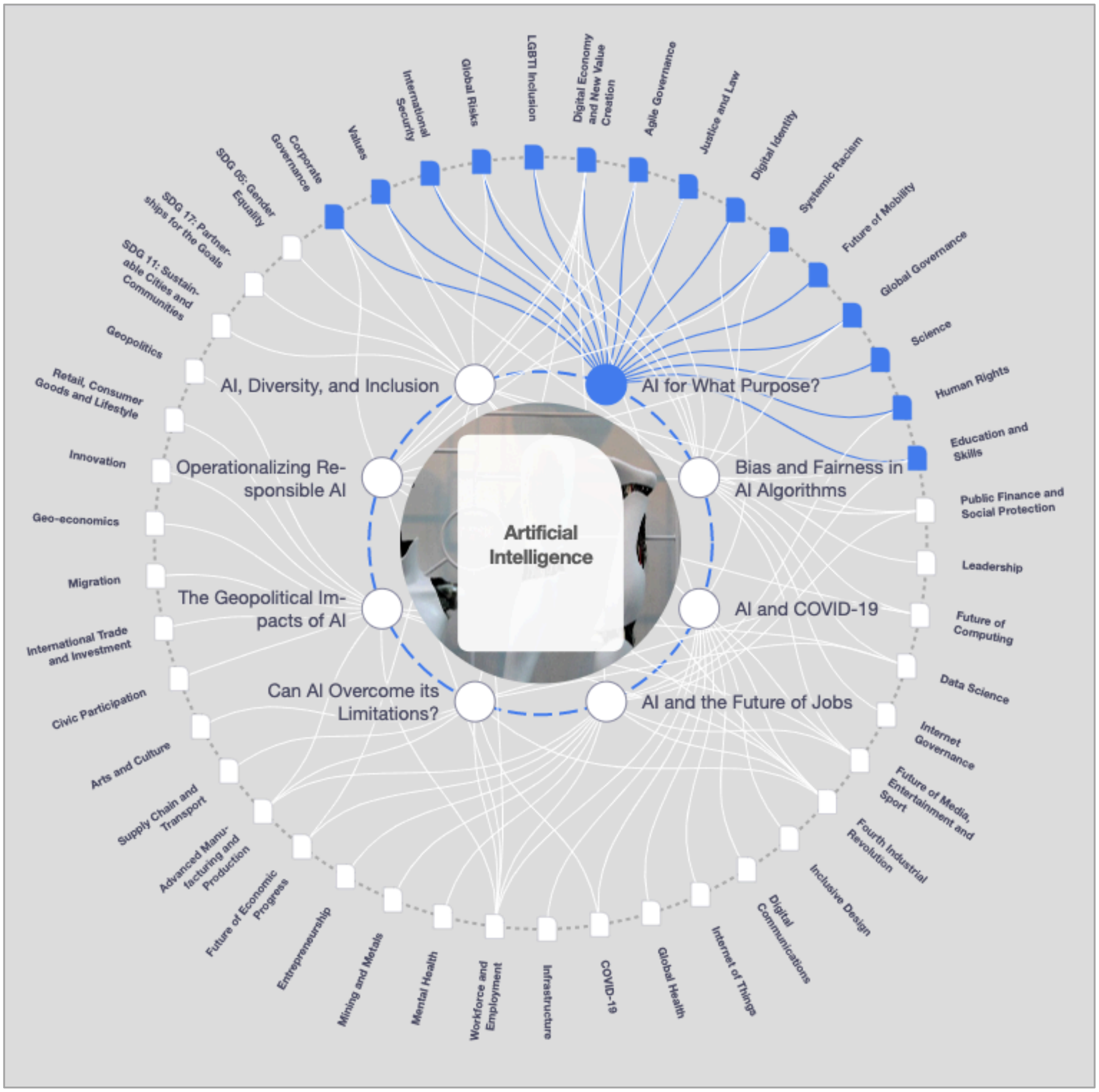

Figure 12. WEF Great Reset Strategic Intelligence Map – AI (WEF, n.d.).

Recurring WEF Key Terms & Phrases. *Figure 13,* WEF Key Terms & Recurring Themes Word Cloud assisted in visualizing some of the overarching viewpoints as outlined in the four pieces of literature. This word cloud tied relative font size to the words relative appearance in comparison to other words. The words presented below were also tied to any key aviation themes that involved CSPO, UAS, job loss or AI influences on the aviation industry. Most interestingly, the word "Multi-Stakeholder" appeared prominently in the illustration, which denotes its common appearance in aviation themed discussions in transitioning to a future state envisioned by the WEF and the Great Reset agenda (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020).

Figure 13. WEF Key Terms & Recurring Themes Word Cloud

Chapter V

Discussion, Conclusions, and Recommendations

The results from Chapter IV sprang from the overarching trend of research acknowledging new discoveries in human brain cognition limitations when viewed through the lens of aircraft automation and digitization, which in turn spearheaded explorations into new adaptive automation models that work best with the human element in light of the short comings of present-day aircraft automation architectures that place human pilots at a known disadvantage under certain flight scenarios. In addition, advances in UAS technology that took place in the shadow of manned aircraft flight deck refinements only recently debuted the stark magnitude of these achievements and are just now beginning to eclipse manned aircraft automation capabilities. Furthermore, evidential global influences into the above developmental research proved uncanny in the pre-pandemic world before the escape of SARS-CoV-2 yet came sharply into contextual focus and was overwhelmingly acknowledged in the post-COVID world with the WEF's calls for a Great Reset. Lastly, and as if almost perfectly timed, ALPA, International's emphatic defense of the standard two-pilot model as the glowing standard of aviation safety and efficiency, published a widely recognized 2019 white paper amid accelerating CSPO research and autonomous aircraft achievements (ALPA, 2019). Each of these threads both parallel and weave together at times as part of a continual ribbon of technological progress that, while aviation focused for now, holds far reaching political, economic, and societal implications that extend beyond the American Part 121 air carrier industry. It is imperative that honest and frank discussions about the future of this industry that proved vital for so long to the greater American economy be chaired by government regulatory bodies with public safety at the forefront, lest the opportunity to shape the narrative be lost to those who stand to profit the most from these sweeping changes by removing the very human element central to the spearheading of the powered flight revolution that took place more than one hundred years ago.

Discussions

Once again, leveraging the benefit of 20/20 hindsight, it is intriguing to see the common themes among the targeted research efforts exploring human cognition, machine learning, AI, and new developments in adaptive automation seemingly able to read, respond and assist the human counterpart, and then review the WEF's pushes for an acceleration of 4IR technology that merges the human element with the digital realm (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020). For entities that may question the revelation of these events as mere coincidence, consider the gravity of them when taken into the context of regulatory acknowledgement, wherein the FAA now openly forecasts the future filled with unmanned and autonomous vehicles carrying paying passengers (FAA, 2021). Acknowledgements such as these from global NGO's such as the WEF, well-regarded aerospace manufacturers within the aviation industry, and now regulatory agencies that held the proverbial line-in-the-sand, should lend credence to what changes lay ahead for not just the American Part 121 aviation industry, but for the entire world.

Serious efforts underway to reimagine the fundamental purpose of aircraft automation should also serve as a clue to what lay ahead for the professional Part 121 pilot network. Accounting for legacy autopilot designs and acknowledging its deficits despite delivering overwhelming flight safety across the decades of aircraft flight deck refinements further feeds into the calculus of how an adaptive autopilot should or could look like. Discussions about the aircraft machine-to-human communication link, and vice versa, acknowledges the 4IR future espoused by the WEF's Schwab and others, while advancements in these explorations make CSPO a viable option for industry to adopt (Schwab, 2017; Schwab & Davis, 2018; Schwab & Malleret, 2020; Vu et al., 2018; Tokadli et al., 2021). Ultimately, reimagining the role and purpose of flight deck automation means reimagining the role of pilots on the flight deck.

Certain segments of the aviation industry may presently scoff at the notion of an unmanned airliner carrying passengers or cargo, however, considering capabilities showcased by both Airbus and FedEx, the clock is ticking down to the expiration of the standard two-pilot flight deck as currently constituted until, at best, some globally accepted CSPO transition date or, at worst, a yet to be determined need in response to some notional emergent scenario necessitating the switch to CSPO or autonomous flight operations (Airbus, 2020; Ostrower, 2021). Unsurprisingly, industry is leading the way into cutting-edge developments, some backed by DARPA technology such as Sikorsky and FedEx quietly marking notable achievements along the way, often with the public back briefed after the fact once passing some breakthrough milestone (Hemmerdinger, 2020; Reim, 2021). Much like the breakthroughs in UAS technology and capability, these achievements by aviation industry and defense contractors proves the above findings as significant and should grab the attention of many stakeholders beyond the aviation industry.

Other clues adding gravity to the current pace of technological achievements lie in regulatory agency acknowledgements and the willingness to leverage the P3 model so openly in working with industry stakeholders further strengthens the argument that change is closer than previously estimated. While entities such as the FAA tread cautiously in announcing particular dates of when the newest research technology might reasonably be expected to achieve regulatory approval or go live, it is particularly adept at setting expectations for the implementation of new regulatory requirements. As an example, take the FAA's January 2020 Automated Dependent Surveillance-Broadcast (ADS-B) deadline, which was openly talked about for at least five years running, with recurring announcements that the deadline would not be moved or delayed, often to the chagrin of many personal aircraft owners (AOPA, 2015). Once again, reviewing the January 2020 ADS-B mandate with the benefit of 20/20 hindsight in comparing this particular deadline juxtaposed against the post-COVID environment the world currently finds itself under and considering the global Great Reset agenda leads to questions that skirt outside the scope of this research paper. But suffice it to say that, under this light, FAA announcements regarding UAS advancements taking place as part of the greater UTM AAM integration plan as outlined within official agency outreach publications further strengthens the idea that sweeping changes to the NAS and aviation industry are overdue.

Viewed against this backdrop, the present economic and technological landscape in which organizations such as ALPA must contend with, places the organization in a precarious position in which to defend its professional pilot constituency considering the union represents flying professionals across passenger carrying and air cargo operations. This position might as well be the proverbial between-the-rock-and-a-hard-place when choosing which narrative in which to best stake a claim in winning the two-pilot flight deck argument, most especially in light of the viable achievements netted by Sikorsky and FedEx (Ostrower, 2021; Reim, 2021). In this light, it is an all or nothing fight for the professional interests and livelihood for each pilot considered a member of one of those most recognized and well-respected pilots unions in the world. Consider the previous occasion when pilot's unions had to fight for their livelihoods back in the 1980's, which was brought on by the roll out of Boeing's then new 757 and 767 aircraft. These new advanced flight deck aircraft forced the contentious argument debating the three-person versus two-person flight decks where ALPA fought to negotiate gainful tasking to be written into each airlines pilot contracts in order to have the inevitably redundant third pilot/flight engineer not feel irrelevant (Fadden et al., 2015). Taking into account recent CSPO and autonomous flight developments, it may seem that the time is ripe for yet another frank discussion on future pilot roles in an aviation industry that posted record profits in the run up to the COVID-19 passenger enplanement collapse (Dunn, 2020).

In acknowledging the above reality, broaching such a painful and sensitive topic with the very stakeholder groups defending the reputation and livelihoods of the professionals entrusted with the safe and efficient operation of thousands of flights every year may prove challenging and uncomfortable. Failure to acknowledge, at the industry-wide stakeholder level, the very research and technology that has been, and is currently under development with the sole purpose of revamping flight deck automation to such a degree that its performance nets the viable reduction of required cockpit crew members from the globally recognized two-pilot standard to a single- or even the lack of a pilot at all, will set off cascades of aviation industry cognitive dissonance that will have never been seen before in the history of powered flight. Furthermore, it should be noted that, should the rapid adoption of said technologies be implemented without prior roundtable discussions considering the traveling public's safety in mind, the fallout's second and third order effects may very well adversely affect other cottage industries that feed into the Part 121 economic ecosystem such as collegiate flight training programs, Part 61 and 141 schools of learning, and other focused learning programs that facilitate the clearing of high aviation industry entry barriers. Finally, and perhaps most importantly, the calls to formalize these discussions at the strategic level should not be emanating from NGO's such as the WEF, but rather from the FAA, Part 121 air carriers, and the pilots unions representing those of the industry's employ, all while leveraging an honest self-introspective approach in tackling this subject head on. Leaving this subject unacknowledged for an unreasonably extended length of time despite the potential for far reaching political, economic, and societal ramifications would represent a systemic governmental and industrial failure of the highest magnitude and result in the severe erosion of the public's trust.

Conclusions

At the beginning of this project paper, the research question asked: To what extent will COVID-19, the Great Reset and the 4IR influence the Part 121 passenger and air cargo professional pilot employment outlook from here into the future? At face value, this seems like a difficult question to answer considering the many variables that affect net employment levels within the historically volatile boom-bust Part 121 airline industry. However, gathering each historical technological advancement thread that influenced the industry since the dawn of powered flight, and comparing each achievement next to one another, the totality of the context becomes clearer. It is no secret that technology is being shaped to design the human out of the cockpit, whether through AI or adaptive automation avenues, however, also noteworthy are the philosophical disagreements within the academic and research fields that point to the shortcomings of present-day aviation automation architectures and that to completely eliminate the human element from the flight deck is not the avenue of choice (Schutte, 2017). Philosophical arguments aside, regardless of which avenue is pursued, adaptive automation or autonomous capability via AI, each in its own respects points to a reduction of the human presence on the flight deck as both CSPO and autonomous flight philosophies are marked departures from the present-day two-pilot standard. Combining then, the NGO strategic visions with academic research philosophies, and the amazing achievements showcased by industry, it is easy to see how the reimagined role of flight deck automation translates into a reimagined role for human pilots, and one not necessarily with two pilots placed side-by-side one another. Under this context, human pilots are losing relevance, and will continue to lose relevance in an industry set to be overtaken by technological advancements championed by the highest levels of governmental and industrial power.

The push is now on to revamp the two-pilot flight deck, and therefore the spotlight is now on the organizations representing professional pilots within the Part 121 industry. In an industry where the effects of SARS-CoV-2 swept away record setting profits, and now is reliant upon billions of taxpayer dollars to sustain the air transportation lines that facilitate economic growth, the calculus has grown more elegant and complex for organizations such as ALPA in defending professional pilot constituents being paid a fraction of normal salary levels to sit at home and not fly (Shepherdson et al., 2021). As argued before, ALPA must thread the political and philosophical needle carefully in this regard as the effects of the pandemic are seemingly far from over, no matter if seasonal changes to passenger enplanements might provide a glimmer of hope that a return to the profitable pre-pandemic days is occurring (Turner, 2021). No matter which direction the economic winds blow, and the second order effects influencing Part 121 professional pilot employment, ALPA must emphatically support the constituency base despite the stark realities affecting pilot livelihood, be they economically or technologically driven. While it may be too early to tell, it will be interesting to note if ALPA's fundamental arguments follow the same path tread four decades previous when they addressed the shift from the three-member flight deck model to the two-member standard (Fadden et al, 2015). Only time will reveal as events play out and the march of technological progress continues.

Recommendations

It is imperative to first acknowledge the ramifications this new technology presents to all industry stakeholders, including the traveling public, in order to spur meaningful discussions on whether or not these advanced technological achievements should be pursued to begin with. Interests beyond potential Part 121 industry profits need to be weighed against passenger safety, NAS integration implications, potential adverse societal impacts tied to job loss, aircraft certification changes and regulatory framework designs. A good example of this is already playing out via the FAA's UTM and AAM strategic plan for UAS integration into the NAS. While following this framework would be a good start, the question of CSPO and autonomous airliners is a more complex issue to tackle from start to finish and requires a more elegant framework to achieve stakeholder buy-in (FAA, 2021).

Once the idea of the how or why to CSPO and autonomous flight is settled, then the question of when needs to be addressed. An agreed upon timeline published and visible to all stakeholders is requisite to earn buy in from all affected parties. To this end, striking balance between safety and capability is paramount. Milestones denoting slow, purposeful and methodical achievements are necessary to realize newfound capabilities without sacrificing safety, no matter how advanced newly discovered capabilities may seem. At minimum, a transition plan encapsulating a decade's worth of time would be a good start in which to settle every questionable concern in forging the path forward.

Ultimately all these changes affect people in some form of fashion. Raising the unacknowledged political, social, and economic ramifications that no one is presently talking about within an open forum makes for the very scenario imagined by Schwab & Davis (2018) about staunch societal resistance culminating at the latest possible moment, which is at the regulatory level serving as the last bulwark of public safety. To speak of the industrial and monetary interests bringing palpable pressure to bear on legacy regulatory frameworks to look past the societal consequences and authorize the very technologies servings as keys to unlocking untold billions of dollars of possible profits tied to the modernized transportation system of the future would be an understatement. In the end it is all about striking the careful balance that avoids the profits over people scenario that seemingly always play out for other industrial modernizations (The Marketing Journal, 2018). Lastly, just because modern technology can remove the human element from the flight decks of tomorrow, does not mean that it should, in the hopes that this newfound capability somehow makes air travel all that much more safe than it already has proven to be with two humans already on the flight deck. To do so acknowledges the narrative that somehow embracing the technology that dispatches us from our humanity is somehow the key to our salvation (Corbett, n.d.). That is unless this is some dystopian threshold we are set to cross thanks to the Great Reset.

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