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Double-Loop Learning and Air Traffic Management Perceptions and Behaviors

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This qualitative study examined management perceptions and behaviors that affect double-loop learning—as well as the defensive routines that inhibit learning—in the Air Traffic Organization of the Federal Aviation Administration (FAA). Nine senior managers from the Air Traffic Organization were interviewed. Resultant themes related to single- and double-loop learning in use, defensive routines, and ways to promote double-loop learning. Management perceptions included that the Air Traffic Safety Action Program promotes a judgment-free environment for identifying safety risks yet is perceived as a way to avoid individual accountability. Increased two-way communication by gathering input from all levels of the organization and decreasing defensive management behaviors (e.g., unilateral control) could increase organizational learning and adaptability. This study is unusual in its examination of the practical implementation of double-loop learning. Moreover, the voices of the air traffic control managers in this study fill a gap in aviation management literature.

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I. Introduction

Learning is essential to any organization's success [1, 2]. Like other organizations using learning for problem-solving and adaptation [3], the Federal Aviation Administration (FAA) is continuously looking for ways to learn and improve safety of the air traffic control system [4]. The FAA has conceptualized air traffic control as a "complex life-and-death system" [5]. Air traffic control is complex and unpredictable, requiring adaptive learning and management to maintain safety [6]. The FAA employs 14,000 air traffic controllers, who have a first duty priority to separate aircraft and issue safety alerts while exercising good judgment [7]. As air traffic controllers are an adaptive element in a systems environment, continuous learning is needed to improve safety and efficiency [8].

The FAA has referred to the need for a safety culture allowing for "self-disclosure of errors" and "due consideration of honest mistakes" [9]. The FAA implemented a safety management system to monitor, assess, and address the associated risk within the operation through system-wide procedures and practices [10]. The National Transportation Safety Board [11] advised all aircraft operators to participate in the FAA's voluntary reporting program, the Air Traffic Safety Action Program (ATSAP). According to the FAA [12, 13], voluntary reporting programs such as the ATSAP help resolve safety issues that otherwise might not have been identified or resolved.

The ATSAP was designed to promote double-loop learning. The ATSAP removes actual and potential problems from the sole purview of FAA headquarters and allows air traffic controllers to safely report risks and errors to the National Airspace System. Employees are promised that no punitive or disciplinary actions will be taken as a result of reporting errors [14]. From there, the data and individual performance are analyzed by both the headquarters members and subject-matter experts from the field to determine solutions.

Specifically, when an air traffic controller files an ATSAP report, the report is reviewed by an ATSAP analyst who removes any identifiable information that could link the employee to the report. The Event Review Committee consists of a member of FAA management from the Air Traffic Organization, a member from the National Air Traffic Controller Association, and a representative from the Air Traffic Safety Oversight Service. The committee may recommend training, which is conducted at the facility of the air traffic controller who filed the report. If multiple reports suggest a systemic issue at a facility, the committee may require a facility-wide Corrective Action Plan, which could include changes in directives, creation of a workgroup, or changes to training [15]. The committee then reviews whether the safety issue has been addressed. Quarterly ATSAP reports and bulletins are shared—with sensitive personal information protected—to show examples of issues and help employees and managers learn from mistakes

[13]. Air traffic controllers can have honest conversations about mistakes, accidents, and incidents and can proactively report any potential unsafe behavior, practices, or procedures. Managers are responsible for creating an environment where reporting is valued.

II. Purpose

The purpose of this study was to examine management perceptions and behaviors that affect double-loop learning—as well as the defensive routines that inhibit learning—in the Air Traffic Organization of the FAA. Despite use of the ATSAP, and 181,288 submitter reports, the FAA [13] reported safety culture as the top systemic safety problem, identified in 42.5% of the systemic problem reports. The top causal factor for safety culture problems was supervisory and organizational factors, particularly "lack of safety culture" [13]. Therefore, this study was designed to help determine ways to improve the use of the ATSAP and other forms of double-loop and organizational learning in the organization to increase safety and promote safety culture. Organizational learning can vary from single-loop learning, which is simply learning from mistakes to improve practices, to more complex double-loop learning, which involves critical reflection and rethinking organizational assumptions and goals [1], as in the example of the ATSAP.

However, the research is limited on the practical use of double-loop learning in organizations. Leaders may not understand how to transition double-loop learning from theory to practice in the workplace, where real-world dynamics and obstacles exist [16]. Double-loop learning, although a sound conceptual theory, still has not yielded a practical roadmap or lesson plan for direct application. Executives may still be afraid to change the status quo; researchers may face the same opposition, yielding difficulty in implementing and studying double-loop learning [17]. In a review of the published research on civil aviation, researchers [18] also noted a significant shortage on aviation management research. This study was designed to help fill these gaps.

III. Conceptual Framework

A. Double-Loop Learning

Argyris and Schön [1] described two types of organizational learning: single- and double-loop learning. Single-loop learning is basic learning from experience. This single loop of testing is basic detection and error correction. Double-loop learning adds an additional loop of reconsidering the basic foundation on which the procedure is based. Objectives, policies, and the status quo and values and mission of the organization may be questioned and adapted [1, 16]. The literature has associated double-loop learning with improved organizational performance [19–21].

Even though double-loop learning has been touted as creating the optimal environment for organizational success, researchers have found the practice of double-loop learning rare [22]. Double-loop learning is likely particularly uncommon in hierarchical, highly structured organizations such as governmental agencies [22]. Additionally, organizational learning is inhibited by defensive routines, which are actions and policies that protect employees or leaders from embarrassment or potential threat but also prevent organizational learning [22–24].

B. Defensive Routines

Studying organizational defensive routines is critical to organizational success, as managers and organizational leaders who do not employ double-loop learning hamper organizational development [25, 26]. Defensive routines include saving face, unilateral control, avoidance of action, delayed decision-making, avoidance of blame or responsibility, and risk avoidance [24]. Alvesson and Spicer [27] described "functional stupidity" of management choosing unilateral power and status quo over two-way communication, thereby inhibiting learning. Defensive routines involve saving face and avoiding embarrassment, frequently at the cost of open information sharing of mistakes. Figure 1 depicts the organizational learning framework of the study.

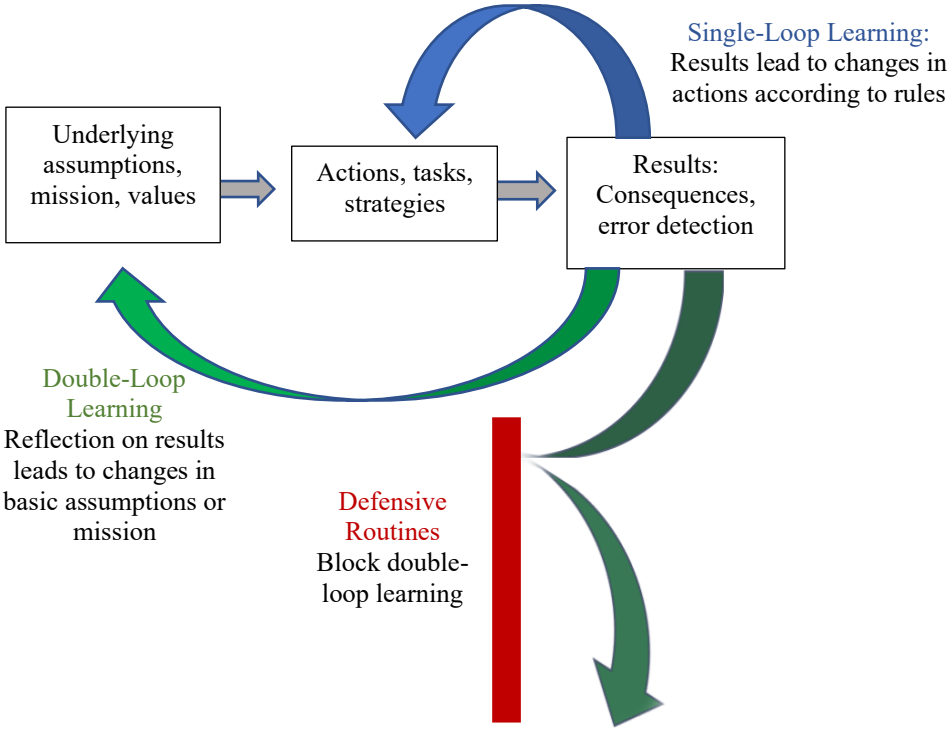

Fig. 1 Double-loop learning conceptual framework.

IV. Methodology

Three research questions guided the study:

1. How do managers perceive organizational learning (including single- and double-loop learning) in the Air Traffic Organization of the FAA?
2. What are management perceptions of defensive routines that inhibit double-loop learning?
3. What are management perceptions of behaviors, policies, and practices that would promote double-loop learning?

Using a basic qualitative design, nine current or retired senior managers from the FAA Air Traffic Organization were interviewed. Each line of business within the FAA has an organizational chart that depicts status, job title, and level within the FAA. As an operations manager at the FAA, one of the authors had access to that chart. Thirteen FAA senior managers received an email asking if they would like to participate in the research study; nine volunteered. Interviewees had 14–40 years of experience in various roles and facilities with the FAA, and all had former military experience. All had worked for the FAA for at least 3 years before the implementation of the ATSAP in 2010. Three of the interviewees were women. The interviews represented a small number of participants who were chosen as likely to provide in-depth, rich data [28]. All rules, regulations and guidelines were adhered to in accordance with U.S. federal code [29] as well as the George Washington University Institutional Review Board. All participants signed informed consent forms and answered the same semistructured interview questions. Additionally, the critical incident technique was used to ask participants to reflect on a specific incident [30]. The critical incident technique was used to explore responses, critical thinking, and decision-making processes of interviewees. By asking participants to recall a particular incident, specific managerial responses could be determined (see Interview Questions 9, 10, 11, and 13 in Appendix A).

Codes and emergent themes were analyzed from the transcribed interviews to answer the research questions [28]. The theoretical lens of double-loop learning and defensive routines guided the initial coding process as a priori codes. For example, a priori codes related to double-loop learning included change in mental models, two-way communication, and collaboration; a priori codes related to defensive routines included control, saving face, and blame. The remaining phases of coding involved inductive analysis [31] with in vivo or descriptive codes [32]. In addition to analyzing the transcript text, a technique [33] was used to observe interviewee speech patterns when asked

about defensive behaviors, such as a long pause, deflective humor, or blaming others. See Appendix A for the interview protocol as used with participants.

We used data saturation to ensure adequacy of sample size. Data saturation is the point at which continued interviews reveal no additional codes or data [34, 35]. Braun and Clarke [34] recommended a sample size in thematic analysis ranging from six to 16 interviews, depending on data saturation; they noted they have been incorrectly cited as stating 12 interviews is required, but they did "not say anything like this." As an example, one study [36] reported saturation within the first six of 20 interviews. Although we only had nine participants, they offered detailed interview responses, and we achieved clear data saturation. An open coding method generated 54 codes; we reached data saturation by the sixth interview (see Figure 2). We then collated the open codes into 25 categories, which again revealed saturation by the sixth interview. See Appendix B for the list of codes and categories.

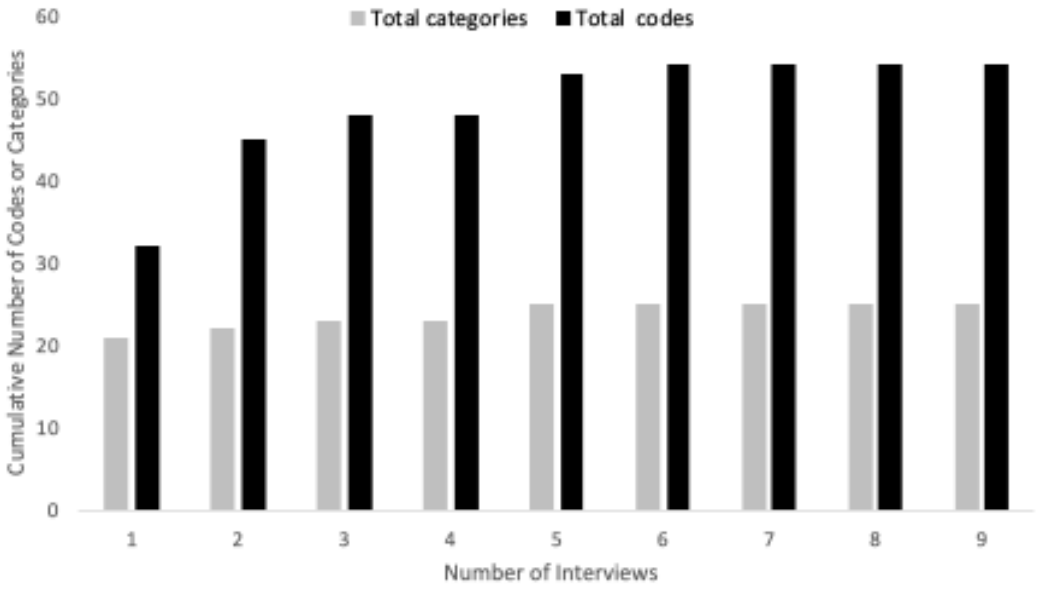

Fig. 2 Data saturation: Cumulative number of codes and categories by interview.

The small sample size in this particular study was appropriate for several reasons. First, we achieved data saturation quickly and conclusively [35, 37]. Second, the study population was deliberately homogeneous for the purpose of the study—senior air traffic control leaders at the FAA, serving in Washington, DC (although they had served in various air spaces around the United States, as air traffic leaders tend to be stationed in multiple towers over their careers). One participant was directly involved in creating the ATSAP. Third, the participants provided rich data. We expected

them to be somewhat guarded given the potentially negative topic and their careers—and yet they opened up to the first author and expounded in detail on both their concerns and their hopes for air traffic control management at the FAA. We used critical incident technique, which has been used in behavioral interviews within the management and aviation organizations as well as organizational learning [30, 38].

V. Limitations and Delimitations

The senior managers interviewed were all recruited from Washington, DC, a limitation of the study. However, they each had experience at multiple facilities and regions. FAA air traffic employees tend to move among various sites; at the time of the interviews (October 2021 through January 2022), two of the interviewees were working in different states. The first author worked in three facilities during 2021. Seven of the interviewees had worked with the first author in some capacity, although not always in the same department and never as a subordinate of the researcher.

Bias is always a potential limitation in research. Conducting interviews within the organization was useful, as the first author was familiar with the atmosphere and culture of the organization. Researcher bias was mitigated through a reflexive process of recognizing bias prior to data collection and analysis. As an FAA manager, the first author and interviewer recognized preconceptions and biases in advance, so he could bracket out those biases to avoid interference with data collection and analysis [39]. A qualitative researcher should have experience with the issue being researched—while also being able to set aside personal bias during data collection and analysis [40].

The ATSAP was launched in 2008 but not fully implemented until 2010. The first author witnessed operational error procedures before the implementation of the ATSAP. The facility quality control department would replay audio and video of the event in front of all air traffic controllers at the facility. Everyone in the room was able to identify the person who made the error based on their voice. This type of event review was typically done monthly, created a culture of fear, and contributed to air traffic controllers not wanting to voluntarily identify actual or potential safety concerns. The ATSAP was created to promote a culture of safety rather than one of fear.

Additional techniques to mitigate bias and establish trustworthiness included participant transcript review, peer debriefing, and an audit trail including coding and analysis. The second author does not work for the FAA and served as a peer debriefer to review findings and prevent personal bias from impacting the analysis. Additionally, the transcripts and coding process were presented to the first author's doctoral dissertation chair as part of a transparent audit trail.

VI. Findings

Transcripts were coded and analyzed thematically with codes and categories. Appendix B presents a list of codes, categories, and number of participants for each. These combined patterns led to themes. For example, the data analysis categories of rule following and standardized procedures contributed to the thematic finding of single-loop learning. Although managers had positive perceptions of the ATSAP, they also described defensive routines preventing its complete acceptance among managers. Thus, the categories in Appendix B of "ATSAP: positive" and "defensive routines: individual accountability" contributed to the thematic results related to the ATSAP as double-loop learning amid defensive routines. Finally, they described areas needing improvement in the FAA to improve double-loop learning. Table 1 shows a summary of the findings.

Table 1 Findings by research question

Research question	Findings
1. How do managers perceive organizational learning (including single- and double-loop learning) in the Air Traffic Organization of the FAA?	Single-loop learning: Procedure compliance Components of double-loop learning in place: • Continuous learning and data collection • Adapting to constant change • Collaboration, monitoring, and creativity • Transparency and two-way communication • Critical reflection Air Traffic Safety Action Program (ATSAP): Double-loop learning amid defensive routines: • ATSAP promotes a safety culture and organizational learning • However, ATSAP is also seen as a get-out-of-jail free card that prevents accountability
2. What are management perceptions of defensive routines that inhibit double-loop learning?	Defensive routines exist in the organization: • Unilateral control and top-down communication • Resistance to change • Saving face • Mixed messages • Blame
3. What are management perceptions of behaviors, policies, and practices that would promote double-loop learning?	Two-way communication and input from the front lines

A. Research Question 1: Organizational Learning in Place

1. Single-Loop Learning

Managers stressed compliance with safety procedures. Managers view air traffic operations as a zero-fail mission that is built upon rule-based compliance, as supported by Participant E's observation, "Our rules and regulations need to be complied with. They mean something. They're put there for a reason." Participant G, when asked about leadership style, said, "Regulatory compliant." Following rules is vital in an environment where the safety of the public is at stake, and all participants had military backgrounds, which might have favored following rules and standardized procedures. However, when asked to describe a failure or difficulty in the organization, Participant H described a facility where "standardized operating procedures were extremely outdated, which was causing errors throughout the operation." Single-loop learning certainly is necessary in air traffic control. Rules and procedures are designed to create consistent, safe operations. Organizations seeking to be adaptive should balance both single- and double-loop types of learning to improve basic procedures as well as more fundamental aspects of the organization [41].

2. Components of Double-Loop Learning

A range of formal and informal behaviors can contribute to double-loop learning. As described by the managers, this range included continuous learning, adapting to constant change, collaboration, monitoring, creativity, transparency, and (to a certain extent) two-way communication. Some interviewees described a process of critical reflection but did not term it as such, suggesting they are engaging in the practice instinctively but without formal training on its importance. Appendix B shows the analytic codes and number of participants describing each.

a. Continuous Learning and Data Collection. All nine interviewees stressed data collection as part of their strategy to ensure a safety culture. Seven specifically mentioned continuous learning. Participant B explained, "I get as much information as I can ... to make sound decisions." When asked about strategies to meet the goal of a safety culture, Participant E said, "First strategy was to learn about it." Participant I described data collection as the first step in a tiered approach: "The first thing I think to do is to identify. Once you identify what all of the issues are, where the weaknesses are and where the facility can be strengthened, then you need to go through the process of addressing each one of those things." Participant A described "being aware what's going on in the facility. You know, talking to my other fellow air traffic managers, trying to identify trends." Participants mostly used broad, informal statements to

describe learning at the individual level. Formal, organizational continuous learning stressed repeatedly by all participants was staff development, training, and support.

b. Adapting to Constant Change. Seven participants noted change is constant within the FAA, making adapting a continual requirement. Changes include new technology, new demands, and new policies. Participants noted that a fatal accident would cause overnight changes in procedure. Double-loop learning frequently occurs in times of crisis [22]. Double-loop learning can enhance safe practices by allowing managers to ask whether they are doing the right things and need to change processes or priorities [23]. The FAA changes continually based on crises such as COVID or aircraft accidents; six participants in the study mentioned crisis as related to adapting. Air traffic management involves continual change [8].

As a result, participants included adapting to change as part of their decision-making. Participant B stated, "With the National Airspace System being so dynamic and ever changing and technology just being brought in, in all phases of this, we have to continually evolve." Participant C said the FAA "consistently has to adapt," due to the growth in aviation. Participant E explained, "The number one competency of an FAA employee is resiliency. You have to be resilient. You have to roll with the changes."

c. Collaboration, Monitoring, and Creativity. All participants had former military service and referenced teams. Five participants described collaborating across facilities for information sharing to develop a holistic, formal approach. Six participants mentioned monitoring to make needed changes, often informally. Participant I stated, "Now you have to determine how well are we doing? Are there still gaps? Are there still questions?" Participant E described monitoring as follows: "I do quality control. I edit. I look at policy. I look for opportunities for synergy to see where, where particular, let's say a change in a regulation might affect, or adversely affect, another directive or another policy. I connect the dots. I put people in touch with each other that know things on certain topics."

Six participants described creativity in their decision-making. Creativity allows for adaptability and new ideas to promote a learning organization [17]. Participant G provided a specific example involved examining the funding structure to find a way to replace outdated equipment in spite of "zero budget allotted for me to be able to make a change," resulting in "the magic of addressing a situation that was going to be really bad." Similarly, Participant I overcame a bureaucratic overload by creatively changing the approval process to dramatically reduce the overload of authorization requests. The new process involved some automation as well as streamlining the process to provide blanket authorizations where appropriate.

d. Transparency and Two-Way Communication. All participants had a military background, and many had worked their way up through the ranks of the FAA to their current executive position. They sought to lead by example to promote trust and two-way communication. Participants frequently cited aspects of transformational leadership such as transparency or integrity (cited by $n = 6$ participants), trust ($n = 7$), setting an example ($n = 6$), achieving buy-in from employees ($n = 7$), and seeking input from all ranks of the organization ($n = 8$). Participant G stated, "Silence is really killer. But you preclude that by ensuring you have a just culture." Participant A described personally "being receptive to the workforce ... allowing them to offer solutions. ... These are the people that are working at the front lines, so maybe they have the best idea of what the solutions should be." However, as noted later in this paper, two-way communication was an area still needing improvement.

e. Critical Reflection. Eight of the nine participants expressed using critical reflection with themselves as well as staff to inform their decision-making, an important aspect of double-loop learning. Had in vivo coding been used only, rather than descriptive coding as well [32], this would not have been a code, as participants did not use the term "critical reflection," and only one (Participant F) used the term "reflect." Moreover, the quotes related to critical reflection were mostly in response to an interview question about feedback and criticism, so it is not known if participants would have described critical reflection without the prompt of that question. Notably, participants viewed the word "feedback" positively and the word "criticism" negatively.

3. ATSAP: Double-Loop Learning Amid Defensive Routines

Participants valued the ATSAP as promoting a judgment-free environment for learning. Allowing a judgment-free system to voice concerns without fear is an important aspect of double-loop learning [42]. Even when proposed solutions are simple or at the individual level (e.g., additional training for an air traffic controller), the process of gathering error reports and then reflecting on the data broadly, including possible need for changing assumptions or policies, represents double-loop learning. However, an unexpected finding was that managers also perceived the ATSAP (or reported widespread perceptions) as a "get-out-of-jail-free card" preventing employee accountability. Defensive routines continued to hamper the perceptions of the ATSAP as an effective organizational learning tool. These two findings are elaborated on in the next subsections.

a. ATSAP Promotes a Safety Culture and Organizational Learning. The voluntary safety reporting program allows data gathering and analysis to make systemic improvements to organizational safety and support double-loop learning. Participant H credited the program with bringing different aviation organizations together "to develop a complete

safety culture." Participant I defined a safety culture as "a no-judgment type of environment that allows learning to take place." Participant G explained, "It [ATSAP] changed the mindset of blaming an individual to then looking at the one individual as a part of a system. And I thought that was pretty great because, like many other people, I don't think one individual is the problem. I think it's more of a program-based and systemic type of issue. Being able to address it that way was a big plus for the FAA." Participant F said, "Kudos to the agency for adopting a safety culture mindset. ... I think that was a huge adjustment." Participant F noted the program helped create a "just culture in which people were not threatened with having to go back to remedial training or lose all their certifications because of one oversight, one error, one time in which maybe they were overloaded with traffic and couldn't keep up."

The ATSAP allows information gathering and comparison across facilities to determine solutions, according to Participants B, F, and I. Participant A explained, "The reason that we have ATSAP is to not look at the individual person but to look at the system and how we can make corrections within the system." Jaaron and Backhouse [20] operationalized double-loop learning to include "systematic-operations improvement." Additionally, Participants C, F, and J described the ATSAP as "proactive." Participant D said, "I think it encourages recording of things that ordinarily would've been swept under the rug. And then we can adjust and make changes to mitigate those safety issues that are brought to light through ATSAP. I think it's a great program." Thus, the program allowed for judgment-free reporting of error and reflective review of these reports to determine whether organizational systems or assumptions needed changing as well as the provision of more training.

b. ATSAP Is Also Seen as a Get-Out-of-Jail Free Card That Prevents Accountability. In spite of promoting double-loop learning, the ATSAP still faced defensive routines in the organization. Although participants viewed the ATSAP as a positive part of a safety culture and information gathering, they also felt the program was misused to avoid individual accountability. Five interviewees used the term "get-out-of-jail-free card." Mindsets might have been changed by the program, but not completely.

One participant in particular reported the program negatively impacted managers' roles, resulting in "an environment of complacency." Participant F disliked that the ATSAP procedure took disciplinary control away from the site manager. Participant I concurred: "Those who do not have intentions to use the program how it was intended can abuse the program. People can use it as a get-out-of-jail-free card. ... If an incident occurs, a controller isn't required to report the incident to management if they file an ATSAP."

Participant E noted that the ATSAP was a huge improvement over the previous, punitive system, but also noted the effect on managers was dispiriting, as they felt they had no performance management abilities: "The union basically runs the show in the FAA, and they [supervisors] have no real say in how performance is managed. ... So, in that respect I'd say that ATSAP has had a very negative impact on the overall safety of the agency."

ATSAP regulations state that employees may not be disciplined or de-certified; however, employees may be required to serve in administrative duties or receive further training. Skill enhancement or corrective action is taken confidentially by either the facility or the employee. Several participants felt without assigning blame and individual accountability, employee performance could not be improved. Some responses reflected blame and control. This topic is related to defensive behaviors and routines, the next section.

B. Research Question 2: Defensive Routines

Three participants stated that all defensive behaviors mentioned by the interviewer were prevalent in the FAA: top-down communication, resistance to change, saving face, mixed messages, unilateral control, avoiding action, blame, bureaucracy, risk avoidance, and lack of trust. The defensive behaviors are described in order of number of participants citing them.

1. Unilateral Control and Top-Down Communication

All nine participants observed unilateral control routines through top-down communication in the FAA. Participant F said unilateral control was "still very prevalent." Participant C said simply, "We don't have any input." Participant B described directors making decisions and policies without consulting those on the front lines: "How could you make that decision without talking to us? We do the work every day. And we could have actually given you some really good information." Participant F noted the need for input from those in the field to make informed decisions and policies, observing that managers put policies into place when they have "no idea of the impact in the field operationally. So the operation is subject to having to suffer through compliance when there's a better way or a better policy could have been formulated."

Participant C described the implementation of the ATSAP policy as top-down communication. Participant A explained people "did not trust" the ATSAP when first implemented. Participant A said, "I think that managers do not understand its purpose and how it can be useful to improve the safety culture."

Some participants, in spite of espousing two-way communication, also revealed they relied on top-down communication. The same participants described trying to avoid "pushback" from staff. Participant B described

receiving unexpected questions from staff during a briefing; rather than gathering input from staff, Participant B went back to "folks that were good with messaging and making sure we deliver the content" differently. The solution was to deliver top-down communication more clearly and effectively to explain how the new tool would benefit the employees and the organization. Participant H directly espoused top-down communication: "Information needs to start from the top, flow down." Such defensive routines block double-look learning.

2. Resistance to Change

Eight of the nine participants mentioned issues with the air traffic controllers' union as preventing constructive change. Participants noted a history of poor labor relations in the FAA. Participant F described union reps as defending negligent employees and misusing the ATSAP for political reasons. Comments by participants suggested a need for more cooperation between managers and workforce. The workforce displays self-interest and resistance to change, and management practices lack adequate two-way communication and collaboration. Participant E mentioned a specific success as crafting policies that were at first resisted by the union; eventually, the union rep acknowledged the good work done. That acknowledgement, combined with the knowledge that lives were saved, made it one of the high points of his career.

3. Saving Face

Participants not only described face-saving behaviors in the organization, but some also demonstrated face-saving during the interview. When asked to describe a time when they experienced or observed failure in the organization, four participants were surprisingly resistant to describe or even remember a failure. Participant C denied experiencing specific failure within the organization and laughed, "I never make mistakes." Participant D said, "Let me circle back to that one," but later in the interview still could not remember a failure. Participant B almost mentioned something and then said, "Let me back away from that one. I don't know if I want to talk about that."

4. Mixed Messages

The defensive routine of mixed messages was referenced by six interviewees, particularly in terms of support for managers. Participant E stated the agency claims to support manager training but provides inadequate funding. Participant E stated, "There's theory, and there's practice." Participant I described "receiving mixed messages from above."

5. Blame

Participants described the FAA prior to the safety culture and the ATSAP as a punitive culture of blame with performance metrics that prevented errors being reported. The organization has improved dramatically. The ATSAP has changed the culture of the organization, promoting more learning and less judgmental blame. However, blame still was reported as a defensive behavior in the organization. Participant I said, "Without accountability, the issues don't get fixed because the focus is blaming instead of finding solutions." Participant B described "how much better things would be" if groups prepared to blame each other instead "got together and said, 'Well, how do we fix this?'" As noted in the findings on the ATSAP, managers wanted to feel someone was held accountable for any error.

C. Research Question 3: Promoting Double-Loop Learning

Managers offered recommendations for practices that could promote double-loop learning in the FAA. Participant I noted a need for more training and open communication in an environment where questions are encouraged. Participant B explained, "Once you stop learning, then I think failure is right around the corner."

Participant F stated, "I think one of the ways that they can improve related to safety is empowering the people who are actually in the field, who actually have to carry out those safety-related functions, that make decisions. ... If you want buy-in, you should also allow input." Participant I agreed with a need for less top-down communication and more collaborative information gathering:

> I think getting input is extremely important. If the agency seeks to get the answers from the lowest level on upward, I think they could definitely receive valuable information they need to improve safety. I think having more participation from the facility level would be helpful with that. Having those open lines of communication is so valuable, because if there's an approach where rules are coming down, instead of open communication going upward, those decisions are being made together, it can lead to a situation where all bases may not be covered.

Broad data collection at all levels of the organization that can lead to changes in objectives and policies allows for organizational double-loop learning.

As Participant E put it, "Speaking truth to power is a very key component of a safety culture and a just culture, and yet in this agency, we're not there yet." Participant G described silence as "the killer." With more input from those on the front lines, the impact of policies will be more clearly understood, preventing inadequate policies and frequent

changes. As Participant F put it, policies are often introduced top-down "without any roadmap to how it gets done." With more two-way communication, the organization can become more adaptive.

VII. Practical Implications

A. Training on Self-Reflection and ATSAP

Managers may need training to incorporate self-reflection more deeply into their practice. Such self-reflection is more likely to help remove residual defensive routines or need for unilateral control. Double-loop learning requires organizations to reflect on beliefs and assumptions [1]. Whereas the FAA has used double-loop learning to implement the ATSAP, the practice of self-reflection is not common in management and not part of the formal training, based on the personal interviews with the managers in this study. In this study, many leaders were resistant to reflect on instances of failure. Organizations that do not promote self-reflection are less adaptive. For example, without self-reflection, employees who view themselves as experts are less likely to notice or admit to errors [43], and staff may face negative consequences for discussing problems without having a solution ready [27].

Changing mental models to allow for nonpunitive feedback is a critical part of the ATSAP. Such change may require deliberate changes in perspective through training. Nicolaides and McCallum [44] described meetings in a governmental organization where staff at all levels considered their individual perspective, that of other individuals, and that of the organization as a whole. Staff considered double-loop questions about individual blind spots or biases, reconsideration of norms, and dynamics at play.

B. Increased Two-Way Communication

Dominant problems were top-down communication and a need for blame, which have impacted the acceptance of the ATSAP and a safety culture. Input from those who work on the front lines is vital. Additionally, two-way communication can be displayed with joint messages and verbal briefings from senior FAA management and senior union leadership from the National Air Traffic Controllers Association. Currently, joint written messages are disseminated to the FAA workforce but joint verbal or face-to-face messaging by both parties is rare. Notably, when air traffic controllers are promoted to supervisor status, they are no longer part of the union.

An ideal organizational environment for air traffic controllers is one where two-way communication, shared goals, shared values, and mutual respect are important, as they are associated with a safety culture and profitability [45]. Learning that is bottom-up is based primarily on experience, whereas top-down learning is based on goals and task

demands [46]. Both dimensions complement one another in two-way communication [46, 47]. Top-down implementations may be a way to coerce frontline employees to have a single-loop learning mental model due to the goals and targets being set by senior management [48]. Double-loop learning is uncommon in hierarchical governmental agencies [22].

As an organization, the FAA can improve on this practice. Some participants, in spite of espousing two-way communication, also revealed they relied on the practice of top-down communication as a form of control. Rather than thinking in terms of pushback from staff, leaders could be gathering input from the field. Espoused theory had not yet become theory-in-use. Organizational behavior is constructed from theory in use rather than espoused theory [25].

C. Addressing Resistance to Change Related to ATSAP and Unilateral Control

Change requires continuous learning. An important implication for the FAA is that, even though the FAA [49] literature for managers explains that the ATSAP does not limit a manager's performance management tools, managers do not have the same perception. Multiple instances of noncompliance from an individual, or errors resulting from substance abuse, will result in direct corrective action rather than the ATSAP process [15]. Therefore, the system has been designed to allow performance management. Yet, managers do not seem to understand that aspect. Managers are still struggling with the notion of air traffic controllers being able to admit mistakes via the ATSAP and not be disciplined. The FAA needs to communicate the benefits of the system to overcome residual defensive behaviors among managers.

Researchers have argued that confidential reporting systems have a positive effect on learning from incidents and should be an essential part of any organization [50, 51]. Unilateral control supports and incorporates face-saving defensive routines that make air traffic controllers as well as managers fearful of being vulnerable to admit mistakes and errors, hindering the exploration of new mindsets or practices. The ATSAP provides the Air Traffic Organization with a viable model to detect and correct error, providing vigilant monitoring of the National Airspace System through accounts of safety events from frontline employees (air traffic controllers). Yet managers still have trouble fully believing in the ATSAP and its benefits. Argyris [52] stated, "Top managerial level is typically at the forefront of espousing change but not producing it."

More internal FAA research is needed to determine why. Participant E stated, "There needs to be a balance between ATSAP, which is essentially considered a get-out-of-jail-free card, and performance management." The FAA needs

to investigate a forum with managers to gather perceptions of managers and communicate how managers can still manage performance. The organizational culture will need to shift to create a true safety culture. Double-loop learning requires an organizational culture and climate promoting psychological safety and teamwork [48]. Similarly, a safety culture requires interpersonal safety and trust within an organization [53, 54]. A strong safety culture normalizes admitting mistakes and calling for help when needed.

VIII. Implications for Future Research

A. Replicate This Study With More Participants at All Levels of the Organization

A limitation of this study was a small number of participants. Many had worked with the FAA in various areas of the United States; however, a broader sample might produce additional information. Additionally, this study was limited to managers only. A similar study interviewing or surveying air traffic controllers rather than managers is needed to supplement the findings of this study. Additionally, the "us versus them" attitude with managers and the union is an area of further research. Given that managers typically have been promoted from the ranks of air traffic controllers, the strife between the two groups is surprising. More research data are needed from the front lines.

B. More Practical Research on Defensive Routines and Double-Loop Learning

This study was designed to help fill a large gap in the existing research. Few studies have explored real-world practical examination of double-loop learning in organizations as well as defensive behaviors that inhibit organizational learning. In this study, respondents expressed that various defensive routines listed in the interview question were demonstrated at the organization. However, they did not offer extensive detail on defensive routines. More research is needed on practical ways organizations can incorporate a culture of reflection to instill double-loop learning.

IX. Conclusion

Improved organizational learning can lead to better air traffic safety. The U.S. Department of Transportation in 2021 [55] called on the FAA to strengthen safety management systems, use data and analytics to proactively address safety risks, promote examples of robust safety culture practices, and expand the use of nonpunitive reporting programs to enhance and ensure a safety culture. The voluntary safety data reported through the ATSAP provide frontline feedback. Safety voluntary reporting programs such as the ATSAP significantly contribute to the U.S.

commercial aviation safety record and are supported by airlines and other modes of transportation around the world. According to the FAA, voluntary safety reporting programs such as the ATSAP have improved safety, training, and maintenance procedures. The program has added elements of double-loop learning to the organization by providing information to change the status quo of the organization and adapt objectives and policies accordingly. The program is designed to strengthen the safety of the FAA through an improved, nonjudgmental culture of safety.

Yet, the FAA has reported safety culture as the top systemic safety problem. Findings revealed ways managers use double-loop learning and yet also how defensive routines prevent full acceptance of a double-loop learning safety initiative. The findings of this study provide a basis for practical changes to training and communication within the organization to improve the safety culture.

Unlike single-loop learning, double-loop learning involves critical reflection and rethinking of organizational assumptions and goals. Managers used various elements of double-loop learning to make better decisions and develop employees, such as continuous learning, collaboration, and adapting. Managers also perceived that defensive routines limited double-loop learning in the organization. The major problem appeared to be unilateral control through top-down communication. The ATSAP has changed the culture of the organization to a degree, promoting more double-loop learning and a less judgmental safety culture. The organization shows adaptability to constant change. However, more two-way communication will develop a more adaptive safety culture. Gathering input from all levels of the organization and decreasing defensive behaviors such as a need for unilateral control could help the organization become more adaptive and increase organizational learning.

The organizational culture must shift to create a true safety culture. A strong safety culture normalizes admitting mistakes and calling for help when needed. The benefit of the ATSAP is that it promotes not only air safety but also psychological safety internally by allowing air traffic controllers to report risks and errors to the National Airspace System without fear. More safety internally creates more safety externally. However, despite the intention of creation of trust and psychological safety within the organization, these elements remain underdeveloped in the agency. Managers must feel able to relinquish some unilateral control to promote trust in the organization. The FAA and other organizations must commit to an organizational culture of reflection, regular review of routines, and two-way communication. Adding these elements to the FAA safety management system would lead to improved safety.

Appendix A: Interview Protocol

Thank you for agreeing to participate in this study. The purpose of this study is to examine management perceptions of behaviors, policies, and practices that affect double-loop learning in the FAA. Studying organizational learning in the FAA may improve air traffic safety. I have completed a pilot study with Air Traffic Organization (ATO) employees who have had a favorable response to the interview. Let's review the Informed Consent Form again. I would like to make sure you have a clear understanding before we begin. Do you consent to this recorded interview? You may discontinue this interview at any time. Please do not hesitate to ask any questions about the research or interview questions.

Additionally, I just want to point out a few things; this is completely voluntary, and you are able to stop this process at any time. I want to ensure you that your information is completely anonymous and, to the best extent possible, no data will be traced back to you. Also any future publications of this material will not include your name or any other identifying data. All documents will be password protected.

As described in the Informed Consent Form, you have been selected because you are a senior manager at the FAA. The goal of this research is to interview senior managers from the Air Traffic Organization within the FAA regarding organizational learning. You may add to the growing body of knowledge of organizational learning by sharing your valuable experience helping the Air Traffic Organization implement nationwide contingency plans for administrative staff and air traffic controllers. Your input will help create the management literature of the future and provide answers and strategies that can help leaders at all levels learn and make better decisions.

1. Tell me about your work history with the FAA and prior to the FAA? Do you have military experience?
    - Probe and clarify if needed
    - (If applicable, What did the military experience teach you that you are using with the FAA?)
2. Based on your experience, help me understand what makes a good safety culture.
3. Describe how the organization has had to adapt to meet safety or general success goals.
4. How has the Air Traffic Safety Action Program (ATSAP) impacted the FAA?
5. In what ways have you made changes based on ATSAP? Think on those incidents and describe them. What were they, and why?
6. Help me understand what makes a good safety culture.
7. What strategies do you take to meet these goals of a safety culture?
8. Describe your leadership or management style.
9. Tell me about a time when you worked on a really successful project in the organization. Who was involved? How was recognition given?
10. Can you tell me about a time when you or your operational area experienced failure or difficulty in the organization? Can you tell me about a specific incident?
11. Think about a recent important decision you made. Can you describe how you made that decision?
12. I'm going to describe some behaviors. Do you recognize any of these behaviors as occurring in your organization, with you or others?
    a. Mixed messages. For example, "Be innovative, but watch the budget." Or agreeing to follow policy whether or not you actually plan to do so.
    b. Lack of discussion of possible pitfalls or mistakes. No risk taking.
    c. Face saving. Not discussing errors to save your own reputation or a coworker's. Denial of problems.
    d. Blaming others, particularly external sources

e. Avoidance of action, maintenance of the status quo, and resistance to change. Red tape.

f. Unilateral control. Lack of group decision-making, a right-or-wrong leadership style, short-term perspectives.

13. Can you tell me about a time where there was a change in policies or procedures. Describe how you handled the change?

- Who was involved in the change?
- What was your role in the change?
- Did you anticipate any resistance to the change? If so, what steps did you take to deal with it?

14. Can you tell me how you handle feedback and criticism?

15. How have you been able to progress throughout your career?

16. How can the FAA improve decision-making related to safety?

17. How can the FAA help you improve as a leader?

Do you have any additional comments?

Thank you for your time. I will email you a copy of your transcribed interview within 30 days. Please read through it and make any changes for accuracy within 10 days and email it back to me, if you have any changes.

Appendix B: Detailed Categories and Codes

Category	Code	Participant *n*
Single-loop learning (SLL): Rule-following		6
	Rule-following	6
	Emphasis/constant reminders of safety	5
SLL: Standardized procedures		4
	standardized procedures	4
	checklists	1
Double-loop learning (DLL): Continuous learning & data collection		9
	Continuous learning	7
	Collect data/information/data-based decisions	6
	Stay educated/up to date	2
DLL: Staff development & support		9
	Training	9
	Develop staff/self	9
	Support, encouragement	7
	Mentor	6
DLL: Collaboration		9
	Collaboration	5
	Good of the facility/system/holistic	5
	Team	4
	Share information	3
DLL: Air Traffic Safety Action Program (ATSAP): positive		9
	ATSAP: positive	9
	Change in mental models, culture	6
	Judgment-free environment	6
DLL: Adapting		8
	Adapting	7
	Constant change	5
	New technology	4
	Proactive	2
DLL: Monitoring	Monitoring/checks & balances	6
DLL: Dialog/two-way communication	Dialog/2-way communication	8
DLL: Critical reflection	Critical reflection	8
DLL: Trust		7
	Trust	7
	Transparency/integrity	6
	Just culture	2
	Walk the walk/set example	6
	Buy-in	7
DLL: Crisis	Crisis/COVID	6
DLL: Creativity	Creativity	6
Defensive routines (DR): All DRs	All DRs	3
DR: Individual accountability		9
	Individual accountability	6
	Performance	6
	Get-out-of-jail-free card	5

Category	Code	Participant *n*
	Difficulty enforcing staff performance requirements	3
	ATSAP: negative	3
DR: Top-down communication	Top-down communication	9
DR: Resistance to change		8
	Union/labor resistance	8
	Resistance to change	6
	Pushback	3
	Self-interest	2
DR: Saving face		6
	Saving face	6
	Resistance to describe or even remember failure	4
	Embarrassment	2
DR: Mixed messages		6
	Mixed messages	6
	Funding challenges	2
DR: Unilateral control	Unilateral control	6
DR: Avoiding action	Avoiding action/ignored	6
DR: Blame	Blame	4
DR: Bureaucracy	Red tape/bureaucracy	3
DR: Risk avoidance	Risk avoidance	3
DR: Lack of trust	Lack of trust	2

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