2013

Identifying the Impact of NextGen on the Job of Air Traffic Control Specialists in the Mid-Term

Emily Baumann

Kelley J. Krokos

Cheryl Hendrickson

IDENTIFYING THE IMPACT OF NEXTGEN ON THE JOB OF AIR TRAFFIC CONTROL SPECIALISTS IN THE MID-TERM

Emily Baumann, MS
Kelley J. Krokos, PhD
Cheryl Hendrickson, PhD
American Institutes for Research
Washington, DC 20007

By leveraging existing and new technology, the Next Generation Air Transportation System (NextGen) is proposed to support significant increases in both capacity and efficiency of the National Airspace System (NAS). In the decade that has passed since NextGen was mandated by Congress, the Federal Aviation Administration (FAA) has made great progress in identifying the specific technologies, automation, and procedures (i.e., NextGen Drivers) necessary to support the desired increases. American Institutes for Research (AIR) describes its strategic job analysis, which was designed to identify the NextGen Drivers that are proposed to be implemented by the NextGen Mid-Term (2018), and to evaluate how the job of Air Traffic Control Specialists (ATCSs) would change as a result of their implementation. Implications for human resource systems such as pre-employment selection and training are discussed.

The Next Generation Air Transportation System (NextGen) is part of the VISION 100 – Century of Aviation Reauthorization Act (P.L. 108-176) mandated by Congress nearly a decade ago. The impetus of NextGen was the need to increase the capacity of the National Airspace System (NAS) to meet the predicted demand for US air travel in 2025 while simultaneously maintaining or improving reliability and safety. In order to accomplish significant increases in both capacity and efficiency, the implementation of NextGen will leverage existing and new technology, including satellite-based surveillance and navigation. Collectively, these new technologies and the automation, and procedures they support (labeled "NextGen Drivers") are proposed to be used – either directly or indirectly – by Air Traffic Control Specialists (ATCSs). For example, Data Communications is a digital communication system that will provide ATCSs with the capability of directly communicating with pilots using a computer-based data entry system—assuming that the aircraft are properly equipped and that the message meets certain operational guidelines.

It is necessary to understand the nature of the impact of the NextGen on the job of ATCSs, so as to inform important processes including whether pre-employment selection or training for the job will need to be modified. With this purpose in mind, the Federal Aviation Administration (FAA) funded the American Institutes for Research (AIR) to develop a vision of the job of ATCSs as it is proposed to exist in the Mid-Term 2018 stage of the NextGen evolution. As described below, AIR researchers conducted a Strategic Job Analysis (SJA) to identify and define the job of ATCSs working in all three job options – Airport Traffic Control Towers (ATCTs), Terminal Radar Approach Control Facilities (TRACONs), and Air Route Traffic Control Centers (ARTCCs).

Methodology

An SJA is the process of defining a job that is being redesigned or created in terms of the work that employees will perform and the characteristics of workers that will be required to perform those activities (Schippmann, 1999). In the case of job redesign, it is especially important to take note of the impact that any system changes will have on the job and redefine the job in its anticipated form. As a result, the first step of the SJA was to update the job analysis data for the ATCS job as it is currently performed. AIR conducted a series of focus groups with subject matter experts (SMEs) including ATCSs, managers and

supervisors, and trainers and instructors from both the FAA Academy as well as FAA facilities. The goal of the focus groups was to update the lists of ATCS Tasks required to perform the job and the Knowledge, Skills, Abilities, and Other Personal Characteristics (KSAOs) required to perform the job successfully. In addition, AIR developed a comprehensive and current list of the Tools and Equipment used by ATCSs.

Next, researchers identified the NextGen Drivers that would likely impact the ATCS job by 2018. The Drivers were identified through a number of research activities. First, the NextGen research literature was reviewed, including NextGen Concept of Operations documents (FAA, April 2010), implementation plans (FAA, March 2010), human factors roadmaps, and functional requirements documents for specific technologies and automation. Next, focus groups and interviews with NextGen SMEs were conducted to get detailed information about NextGen plans, specific NextGen Drivers, and the likely impact of the Drivers on the ATCS job. These experts included systems engineers, human factors engineers, and aerospace engineers, and other individuals actively involved in conceptualizing NextGen or designing specific Drivers.

After identifying the NextGen Drivers that were proposed to be implemented by 2018, researchers examined and compared the Drivers to the FAA's list of NextGen Operational Improvements (OIs). The FAA's OIs capture specific enhancements to processes associated with the progression of aircraft through the NAS. The goal was to assure that the FAA's OIs were captured in one or more of the identified Drivers. First, AIR determined which OIs would affect which job option(s). OIs that were not expected to affect the ATCS job in at least one job option were eliminated from further consideration. Next, AIR conducted research to determine which Driver(s) would support or operationalize each OI in each facility type to illustrate the relationship between OIs, the three ATCS job options, and the specific mechanism (i.e., NextGen Driver) that would enable the OI to be realized. In both steps, four researchers made these determinations independently and then discussed their individual assignments as a group until they reached consensus.

The final step of the SJA was to determine the impact of the NextGen Drivers on the ATCS job as it is performed in the three job options (i.e., ATCT, TRACON, and ARTCC). The goal was to identify the changes to the ATCS job and to draw conclusions regarding the impact of these changes on the pre-employment selection and training systems. To begin, researchers worked independently to identify if the implementation of a Driver would require new Tasks to be added to the existing lists; would require existing Tasks to modified or deleted from the list; and whether it would change how a Task would be conducted in 2018 (e.g., if a new Tool or Equipment would be added or if information sources would change). After completing the research independently, researchers met and discussed the results until they reached consensus. The process was the same for the KSAOs with the exception that researchers also determined whether a Driver would change a characteristic of KSAOs required in 2018 (e.g., if a KSAO would become more or less important or the required level of proficiency would change).

Results – Identification of NextGen Drivers

A complete list of the 27 NextGen Mid-Term Drivers identified in 2010 by AIR for each facility type is shown in Table 1 below. Drivers range from aircraft equipage supported by satellite technology (e.g., Automatic Dependent Surveillance-Broadcast) to new ATCS automation (e.g., Tower Flight Data Manager) with embedded decision support tools (DSTs) that will be added to the ATCSs' work environment to new policy and procedures (e.g., Integrated Arrival/Departure Air Traffic Control Service) consisting of new routes and new separation standards that ATCSs will be expected to follow. As seen in the table, AIR defines Drivers by facility type. For example, 4-D Wx Data Cube is included in the table three times, once for each facility type in which it is expected to be deployed. This method,

while it allows AIR to describe the sometimes considerable differences in the impact of the Driver by facility type, results in 27 Drivers when there will be fewer actual core programs.

Table 1.
Crosswalk of NextGen Drivers by ATCS Job Option.

ATCT	TRACON	ARTCC
4-Dimensional Weather Data Cube	4-Dimensional Weather Data Cube	4-Dimensional Weather Data Cube
Airport Surface Detection Equipment-Model X		
Automatic Dependent Surveillance-Broadcast	Automatic Dependent Surveillance-Broadcast	Automatic Dependent Surveillance-Broadcast
		Conflict Resolution Advisories
Data Communications		Data Communications
	Flexible Airspace Management	Flexible Airspace Management
		High Altitude Airspace
	Integrated Arrival/Departure Air Traffic Control Service	Integrated Arrival/Departure Air Traffic Control Service
Integrated Arrival, Departure, and Surface	Integrated Arrival, Departure, and Surface	
	Optimized Profile Descent	Initial Tailored Arrivals
	Performance-Based Navigation	Performance-Based Navigation
Terminal Automation Modernization and Replacement, Phase 3	Terminal Automation Modernization and Replacement, Phase 3	
		Time-Based Flow Management Program
Tower Flight Data Manager		
Wake Turbulence Mitigation for Departures	Wake Turbulence Mitigation for Arrivals	

Results – Impact on Tasks, KSAOs, and Tools and Equipment

Results of the SJA revealed several effects of the NextGen Drivers on the ATCS job. In only a few cases, the implementation of the NextGen Drivers will require additional (new) job Tasks. For example, in ATCT and ARTCC, new tasks will be required to establish and terminate Data Communications. However, across job options, the results of the research showed that the job Tasks performed by ATCSs will change very little by 2018. That is, few additions, deletions, or modifications will need to be made to the existing Task lists. This is due in part to the nature of the NextGen Drivers; they are designed to help controllers do their job more efficiently rather than change *what* they do. ATCSs will have access to more information and also more accurate information, which will improve their situation awareness and decision-making. Although relatively few changes are called for in terms of changes to the existing Task lists, there will be a number of changes regarding *how* the job Tasks are performed. For example, new workstation automation will change how ATCSs perform their current job responsibilities by 2018. Finally, the implementation of the Drivers adds more decision branches that controllers must navigate to

conduct various Tasks, which could lead to an increase in their mental burden. However, this increase could be offset by the introduction of DSTs designed to help controllers work more quickly and to allow them to focus on other more challenging aspects of their job. However, note that the net effect on workload is currently unknown.

In addition to having an impact on job Tasks, the Drivers will also have a minor impact on the requirements of individuals who perform the ATCS job. With regard to KSAOs, across job options and Drivers, the changes include the addition of two new Knowledges (i.e., *ATC Automation* and *Interoperability*), one new Skill (i.e., *Service Orientation*), and one new Other Personal Characteristics (i.e., *Technology Acceptance*). Training content for *ATC Automation* would include the evolution of ATC automation; risks associated with automation (e.g., over or under reliance on automation); benefits of automation (e.g., freeing of cognitive resources for use on other Tasks); automation design considerations including appropriate Task allocation to man and machine; and concepts associated with DSTs including the decision support tool – decision making tool continuum, evaluation strategies, and the concept of automation-based algorithms and the importance of understanding them. Training content for *Interoperability* would include how a specific Tool and Equipment interacts with other Tools and Equipment. This could include information regarding how data will be depicted on a display, how the system as a whole interacts with other existing systems, and if information will be displayed on more than one system.

One new skill was added: *Service Orientation* requires ATCSs to be skilled in providing service to properly equipped air carriers. For example, ATCSs will be able to provide certain options and routes to properly equipped aircraft that will not be available to others. Again, because actual Tasks performed by ATCSs will change very little, no new Abilities will be required. Finally, with regard to Other Personal Characteristics, *Technology Acceptance,* defined as the need for controllers to have positive attitudes towards, perceived usefulness of, and perceived ease of use of technology, will be added. While the Drivers will affect the relative importance of KSAOs, making some more important and some less important in terms of a specific Driver, the overall net effect is not known.

Finally, the Drivers will increase the number of Tools and Equipment in the ATCS work environment. More often than not, a new Tool or Equipment will be added to the ATCS workstation in the Mid-Term rather than replacing an existing one. This is especially significant in the case of the ATCT environment, which has traditionally relied on an out-the-window view to gather information rather than looking down at a radar display as is done in the other job options. The significant increase of Tools and Equipment in ATCTs will increase the heads down time of controllers. This increase in heads down time has grown over time and marks another step along the automation continuum toward full automation. While the net effect of the increased heads down time is unknown, it should be investigated further.

While determining the impact of NextGen Drivers on the ATCS job, AIR identified 19 potential risks associated with the implementation of the Drivers. The risks were grouped into four categories: risks associated with implementation of technology (e.g., Improper Allocation of Tasks to Automation; Mixed Aircraft Equipage); risks associated with the implementation of new NextGen policies and procedures (e.g., Best Equipped, Best Served (BEBS); risks associated with the new NextGen work environment (e.g., Change in Culture; More Dynamic Work Environment); and risks associated with individual controller job performance (e.g., Improper Reliance on Automation or Procedures; Lack of/Inadequate Training). The impact of the risks varies, with some risks being associated with only one or two Drivers (e.g. Loss of Party Line Information), and others being associated with all Drivers (e.g. Technology Development and Maturation). Note that these are potential risks only that may or may not materialize depending on a number of currently unknown factors. Finally, they are not meant to constitute an exhaustive list of all NextGen risks but rather are a summary of the issues based on this research.

Results – Impact of NextGen on Human Resource Systems

As no new Abilities and only one new Other Personal Characteristic will be required as a result of NextGen by 2018, the impact on pre-employment selection is limited. No major revision of the AT-SAT pre-employment selection test battery was recommended. One area for future consideration is whether the current test battery captures the required Abilities and Other Personal Characteristics in the proper proportions. That is, pre-employment selection tests typically sample from the domain of all required Abilities and Other Personal Characteristics in proportions that mirror the importance of those characteristics to performing the job. The impact of NextGen on the required proportions is unknown and should be investigated.

Although the implementation of NextGen Drivers has limited impact on the pre-employment selection system, the impact on training is substantive. This is because of the large number of Knowledges and Skills that are proposed to be affected by the Drivers. Significant investment in developing new training content and training developmental and currently certified ATCSs to prepare them to successfully perform their job in the year 2018 will be required. The Strategic Training Needs Analysis (STNA) conducted by AIR as a follow on task to the SJA estimates in much more detail the impact on training, including the resources required to development, implement, evaluate, and maintain NextGen ATCS training.

Summary and Next Steps

AIR's research suggests that although changes lie ahead for the ATCS job, the job responsibilities for ATCSs will remain largely the same in 2018. ATCSs are provided with additional job aids and improved information and tools, but they remain responsible for separation of aircraft in the Mid-Term. The FAA's current pre-employment selection test battery will be suitable for selecting ATCSs to perform in 2018. However, significant additional training will be required to ensure that ATCSs are fully prepared to perform their jobs in 2018.

With regard to next steps, it was recommended that the FAA begin now to identify the processes that need to be put into place to support these changes including determining how to develop high quality standardized training, and identifying and procuring the resources required to make these modifications. Note that AIR's subsequent STNA completed in late 2012 provided critical information that the FAA needs to begin addressing this issue. In addition to addressing the training requirements for ATCSs, the impact of NextGen on other jobs should be considered. For example, additional work should endeavor to develop NextGen Job Descriptions for other air traffic control positions that interact directly with the line controller such as the traffic management unit (TMU) coordinator, with whom the line controller interacts. Another job category that will be affected is the technical operations (TechOps) job as TechOps employees are responsible for installing and maintaining the Drivers and/or their enabling technology. Although the potential risks identified by AIR are not a comprehensive list of all potential risks, research should be conducted to determine their likelihood and to develop potential mitigations. Finally, it should be noted that NextGen is a fast-moving and evolving initiative; these results are now somewhat outdated. It is recommended that the impact of NextGen on the ATCS job be revisited. Although the results suggest that few if any changes in responsibility will occur by 2018, this may not be the desired result. That is, if it is the desire of the FAA that the job will change by 2018 or beyond (i.e., the Far Term), then a different type of analysis may be required.

Acknowledgements

The American Institutes for Research would like to thank Mr. Dino Piccione, Technical Lead for Human Factors Air Traffic/Technical Operations Research and Ms. Barbara L. Wilper, Scientific and Technical Advisor for Human Factors, both of the Federal Aviation Administration's (FAA's) Human Factors Research and Engineering Group. In addition to sponsoring this research, they also provided significant technical guidance and support.

Managers from the FAA's Air Traffic Technical Training and Oversight group also assisted. Ms. Greta Ballard, Mr. Daniel Lacroix, Mr. Gregory Sanders, and Mr. Mark Marchese procured both information and access to subject matter experts, and participated in focus groups and other reviews.

Numerous other individuals made significant contributions. In particular, NextGen and air traffic control subject matter experts from the FAA, the National Air Traffic Controllers Association (NATCA), and numerous contracting organizations participated in interviews that informed the ideas presented.

The views expressed in this report are those of the authors. They do not necessarily reflect the views of the Department of Transportation, the FAA, NATCA, or any other organization.

References

Schippmann, J. S. (1999). *Strategic job modeling: Working at the core of integrated human resources.* Mahwah, NJ: Erlbaum.

U.S. Department of Transportation, Federal Aviation Administration (2010, March). *NextGen implementation plan*. Washington, DC: NextGen Integration and Implementation Office.

U.S. Department of Transportation, Federal Aviation Administration (2010, April). *NextGen mid-term concept of operations for the National Airspace System [Initial Coordination Draft]*. Washington, DC: Federal Aviation Administration.