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IMPACT OF NEXTGEN ON NATIONAL AIRSPACE ACTORS

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The Federal Aviation Administration (FAA) is executing a transformation of the National Airspace System (NAS) through the implementation of the Next Generation Air Transportation System (NextGen). This paper presents two research efforts related to understanding and analyzing the effects of planned NextGen changes across NAS actors. American Institutes for Research is completing a Strategic Job Analysis and Strategic Training Needs Analysis of two NAS actors. The results are intended to provide recommendations to selection and training requirements necessary to support NextGen implementation. Fort Hill Group is building Human-System Interaction Models (HSIMs) that identify the human-system interactions affected by planned changes for individual and aggregated NextGen changes. The results are primarily being used to identify and mitigate safety risks as concepts are developed and implemented. These projects will provide the FAA with a comprehensive view of the impact of NextGen on NAS actors.

Strategic Job and Training Needs Analyses

A Strategic Job Analysis (SJA) is a future-oriented methodology designed to define a job as it will exist in the future. This methodology is often used to evaluate the impact of changes that are proposed to occur to a job. A Strategic Training Needs Analysis (STNA) is also a form of future-oriented evaluation designed to determine what training will be required to support employees working in that future job. In contrast to analyses designed to describe a current job that typically rely on current job incumbents for information, no employees are performing the future job; no incumbents exist. As a result, strategic analyses rely heavily on the input of experts who are involved in planning, designing, or deploying the proposed changes. The results of these types of analyses are estimates to the extent that they depend on stated plans for the future that are susceptible to changes in technology, funding, stakeholder priorities, and other disruptions.

However, these methodologies are extremely useful to organizations. First, the analyses often result in summaries of planned changes that may not have been available previously, such as when changes are being managed by different groups within a large organization. Second, the summaries may uncover new information about the changes such as risks and interdependencies. Finally, the information that results about the future job and the required training is useful for planning purposes. For example, if an SJA indicates that substantial changes will be required to the human abilities required to perform a job, the organization can plan for the changes that may be needed to the relevant human resource (HR) processes (e.g., recruitment, pre-employment selection test). Given the time and resources required to build and validate most HR systems, having this information well in advance of the changes is critical. The advance notice is also especially important in jobs where the consequence of error is high or whether the training pipeline is long. It was with these benefits in mind that the FAA funded the American Institutes for Research (AIR) to perform a series of strategic analyses to evaluate the impact of NextGen.

SJA and STNA for Controllers

Beginning in 2009, AIR conducted an SJA to evaluate the impact of NextGen on the job of Air Traffic Control Specialists, or controllers, and an STNA to estimate the training required to support the new job by the NextGen mid-term, which at that time was defined as 2018. For the SJA, AIR updated the current job analysis for controllers (i.e., tasks performed; knowledge, skills, abilities, and other personal characteristics (KSAOs) required of the people who perform the job; and the tools and equipment used). Next, AIR identified and described the NextGen technologies, automation, and procedures that the FAA plans to implement by 2018—or Drivers—and evaluated the impact of those Drivers on the controller job. For the STNA, AIR identified all the employee groups that would need to be trained on each Driver; the number of hours of training required; the proposed administration method (e.g., instructor-led training; simulation); and algorithms that can be used to estimate the resources required for each phase of the FAA's training process (i.e., design, development, implementation, evaluation, and maintenance).

The results of that research suggest that what controllers do will not change significantly by 2018, but that how they perform the job will change. As a result, AIR recommended that significant changes would not be needed to the FAA's current pre-employment selection test battery (the AT-SAT). However, significant changes were proposed to be required to the training program for controllers. AIR provided estimates of the training and the significant resources that would be required to support it. This research has been captured in myriad reports and publications (c.f., Baumann, Krokos, & Hendrickson, 2014). However, many aviation professionals contribute to the culture of safety that the traveling public enjoys today. That is, knowing the impact on controllers is critical but it is not enough; the FAA also needs information about the impact of NextGen on other FAA-employed professionals. Furthermore, they need this information in time to build or validate the human capital systems that support this workforce. Of particular interest are the estimated 6000 Airway Transportation Systems Specialists—or technicians—who maintain NAS systems (e.g., Aids to Navigation). Consequently, the FAA funded AIR to conduct similar future-oriented analyses on the job of technician.

SJA and STNA for Technicians

Technicians have a direct and critical responsibility for ensuring the safety of the traveling public. Like controllers, the consequence for error on this job is potentially catastrophic loss of life or property, and the training pipeline is long. Furthermore, the NextGen Drivers identified by AIR in its research on controllers suggested that technicians will also be influenced by NextGen. Consequently, the FAA funded AIR to conduct an SJA and an STNA to evaluate the impact of NextGen on field (i.e., bargaining unit) technicians by 2020 (current mid-term).

The process for conducting the SJA and STNA for technicians has been largely the same, to date, as for controllers. Although this research is in process, AIR has identified the NextGen Drivers that are proposed to affect technicians by 2020. AIR is currently updating the job analysis for how the technician job is currently performed. These two results will be synthesized and evaluated to determine the impact on the job and training of technicians by 2020. Despite the similarities in the SJA process, there are some noticeable differences. For example, although there is significant overlap in the lists of Drivers that will affect controllers and technicians in the mid-term, the lists do differ. For example, technicians install and maintain much of the hardware and software that controllers use. Some Drivers, such as 4-Dimensional Weather, include many hardware and software components that technicians must service, but fewer components with which controllers actually interface. In this case, technicians have more Drivers than controllers. On the other hand, some Drivers are procedures that do not require FAA-owned hardware or software. For example, controllers have to be taught new Performance-Based Navigation routes, but technicians have no role to play in the implementation of new routes.

Once the update to the job analysis of the current technician job is complete, AIR will complete the SJA by evaluating the impact of the identified Drivers on the current job. Then, those results will be used as the foundation for conducting the STNA. Collectively, the results will describe the future job as it is proposed to exist in 2020, and will provide information about the training required to prepare technicians to perform that job by 2020.

Update the SJA for Controllers

NextGen is an evolving initiative; changes in technology, funding, and priorities have had significant effects on various NextGen programs since AIR's first NextGen SJA and STNA were completed. Consequently, the FAA funded AIR to begin an update to its original controller SJA. Although the results are not final, preliminary results show that some previously-identified Drivers have been eliminated completely, while others have appeared on the list. For example, Flexible Airspace and High Altitude Airspace were identified as Drivers in AIR's previous research. However, these concepts are not currently being considered. Similarly, Unmanned Aircraft Systems (UAS) were not identified as Drivers in AIR's previous research but UAS has now been added as a Driver potentially having an impact on controllers by 2020. In addition to changes in the Drivers since the original research, the preliminary results also suggest that what controllers do in 2020 will not be significantly different than today. However, additional research will need to be conducted to evaluate the impact on how controllers perform their jobs by 2020.

Acknowledgements

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NextGen Integrated Human-System Interaction Models

As new NextGen concepts are planned and developed, concept designers will need to consider the impact of these changes to the larger-scale interactions between new systems, procedures, and human operators. This is especially true given the concurrent nature of NextGen concept development and implementation. While many concepts consider the system dependencies and relationships necessary to ensure successful implementation, the impact to human-system interactions and relationships can be overlooked. The Human Systems Integration Roadmap provides a high-level view of the relationship between NextGen infrastructure deployment and National Airspace System (NAS) actors. A more in-depth analysis of individual planned changes is needed to develop specific recommendations for concept developers.

Planned NextGen changes primarily take the form of Operational Improvements (OIs). Each OI includes a description of the planned change, along with additional information on system relationships. While the OI descriptions provide a summary of each individual planned change, there is no direct way to demonstrate the cumulative impact of these changes on actors in the NAS. As such, Human System Interaction Models (HSIMs) have been developed to provide a consistent and scalable depiction of human-system interactions for proposed NextGen changes.

HSIM Development

NextGen HSIMs provides a baseline for graphically representing the NextGen impact to human-system interactions across NAS actors and systems. Each HSIM graphically depicts and describes the actor-actor or actor-system interactions associated with a proposed change. Each HSIM is composed of boxes representing different NAS actors and high-level NAS systems. Arrows represent the interactions between actor boxes and describe the interaction between those boxes. Figure 1 provides an overview of the HSIM data elements.

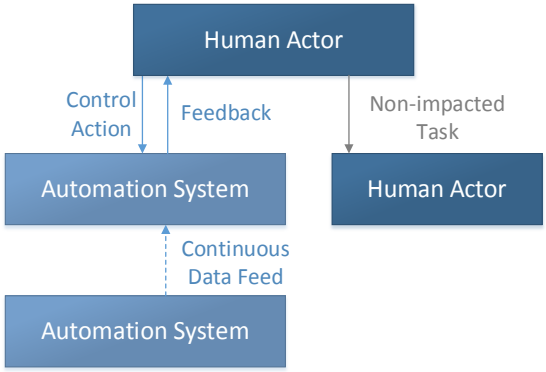

Figure 1. Human System Interaction Model Example

HSIMs are developed based on the text description of a NextGen OI and any additional information available on related systems. A team of air traffic control, commercial aviation, and human factors subject matter experts reviews each OI to first identify the controller and pilot interactions affected by the proposed change. Identified interactions are then used to develop HSIMs for each OI. Multiple HSIMs can then be combined to provide an integrated view of multiple proposed changes.

For example, the HSIM for a proposed radar conformance monitor would depict the en route automation system receiving surveillance and flight plan information and then display the alert to the en route sector controller. Following this, the model would show the controller identifying the alert on their

automation system and issuing instructions to the flight crew to return to their flight path. By utilizing a structured framework for describing human-system interactions, the individual models can be aggregated to show cumulative impacts across multiple proposed changes. Figure 2 provides excerpts from an individual OI HSIM and an integrated HSIM representing four OIs.

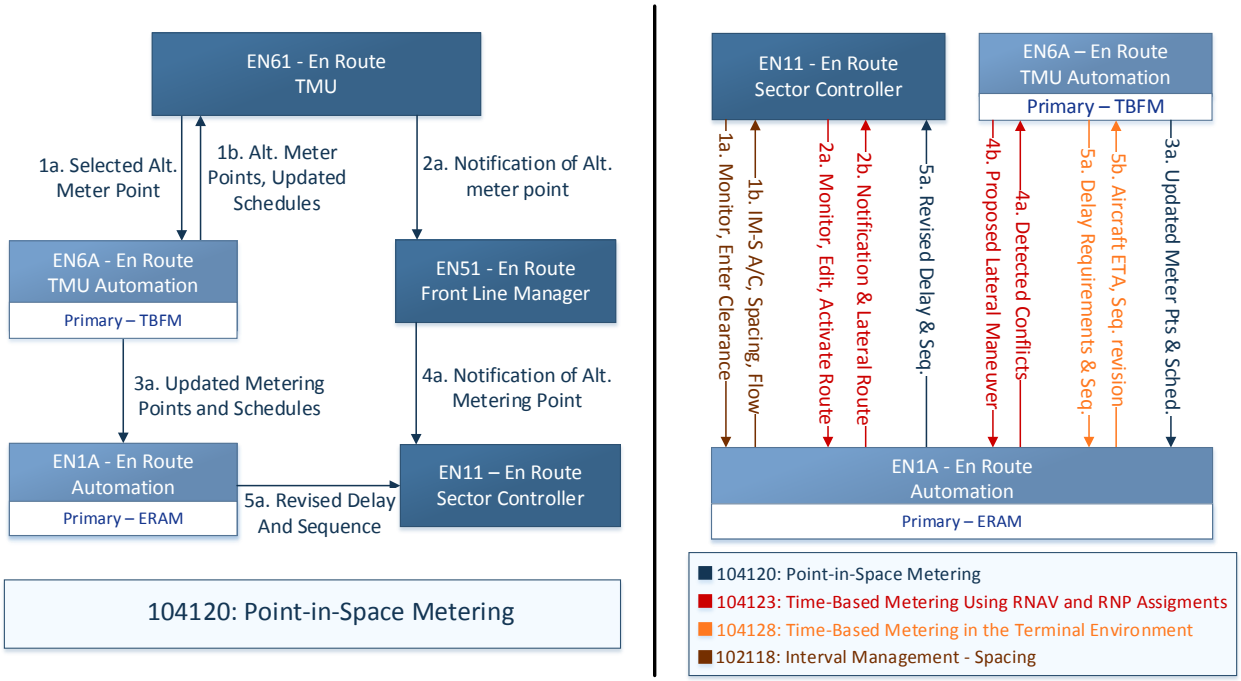

Figure 2. Individual HSIM (left) and Excerpt From Integrated HSIM (Right)

Current HSIM Status

NextGen HSIMs have been created for all planned NextGen changes scheduled for implementation between 2016 and 2020 where human-system interactions will be directly affected. These HSIMs serve as a foundational resource for understanding the impact of planned changes in terms of concept interactions, workload modeling, requirement elicitation, and integrated safety assessment.

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