

Human Centered Automation in NGATS Terminal Environment

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Introduction

Flight progress strips (FPSs) are the primary tool controllers use to coordinate their airspace. Paper strips, however, are a bottleneck in current flight processing systems. Since the information is paper based, actions are mostly coordinated by telephone and logged manually. Alternative electronic solutions, like flight plan data tagged onto the tracks of aircraft on a radar screen, or a mouse driven graphical user interface have already tried to overcome those problems. Most controllers (especially tower controllers) recognize the disadvantage of this kind of representation. First it is hard for the human eye to quickly adapt from bright ambient lighting conditions in a tower, to the relatively dark computer screen and quickly locate the mouse pointer on these large screens. In addition the ongoing proliferation of mouse operated computer displays in Air Traffic Control environments creates the problem of even finding the appropriate mouse device on the controller's workspace. Once the correct mouse is found, the next search starts: finding the pointer on the screen. These problems seem to be negligible, but they increase head-down time and negatively impact the safety and efficiency of operations.

The concept of Electronic Flight Strips (EFS) operated on a modern touch entry display (TED) digitizes the processing and display of flight data while minimizing the impact to air traffic controllers, thereby reducing workload of the controller, and increasing safety and the efficiency of the workflow.

Controller Workflow Automation

Flight strips in Airport Traffic Control Towers (ATCTs) not only support the controller in his tasks but also closely reflect the workflow in the ATCT. Truitt (2006) finds that about 34% of runway incursions are due to controllers forgetting about an aircraft, forgetting instructions issued to an aircraft, or failing to remember the traffic or runway situation. Flight strips act as an essential aid for controllers to keep situational awareness.

FPS handling can be separated into the following classes:

- Strip marking
- Strip moving
- Quality control functions

Strip Marking

FPS are used by controllers as aid in memorizing actions taken, and to be taken, for any particular flight. It also helps the controller to draw the mental picture of the current situation in his airspace. The controller marks actions taken on a flight by marking that action on the strip. The FAA has standard strip marking procedures, which are regulated in FAA Order 7110.65P. However this regulation leaves ample space on the FPS for local ATCT procedures and directives. Table 1 below shows that less than 50% of the space on a strip is standardized. The other part is open to these local variations.

FPS type	Standardized Information Blocks	Optional Information Blocks
Departure Strip	46%	54%
Arrival Strip	42%	58%
Overflight	42%	58%

Source: FAA Order 7110.65P

Table 1 Flight Progress Strip Information Allocation

Although 7110.65P also outlines a standard set of symbols to be used for strip marking, facilities have a large amount of freedom to handle FPS individually as required at that location. Electronic Flight Strips, if designed accordingly can accommodate this wide variety of operations. Categorizing each possible entry provides an effective approach on the electronic media:

- Check mark – Used to indicate completion of certain events, e.g. aircraft cleared for departure
- Time stamp – Used to log the timestamp of an event, e.g. estimated time of arrival
- Numerical value – Used to identify any numerical parameter, e.g. altitude
- Alphanumeric entry – Used to identify e.g. route information
- Strip Annotation – Used to enter notes onto the strip

Electronic Flight Strips have a clear advantage to paper strips as all strip markings are performed in electronic form, ensuring clear legibility independent of the controller. An electronic strip can retain all annotations during the life of the strip, even when moved from one position to the next or from tower to TRACON. This is not the case with paper strips today. In a well designed an EFS system manual annotations should be kept at a minimum. However it cannot be expected that they can be omitted. In badly designed EFS systems controllers frequently have to fall back to making notes on a paper notepad to deal with extraordinary situations.

Strip Moving

The handling of the FPS contains tasks such as

- Strip sorting in the strip bay – FPS are sorted based on departure time, Aircraft ID (ACID) or any other sequence determined by the controller to support his operation. Sorting may be automated or manual.
- Strip cocking – FPS may be horizontally shifted or misaligned in comparison to the other strips in the bay for highlighting or preparing for another action.
- Strip Forwarding – Using a MOVE function on the TED allows the controller to hand off the strip to the next position. The MOVE function can automatically determine, which controller is the next to handle the flight or the originating controller may select the destination manually. This operation is adaptable to the operational workflow of each individual ATCT.

Moving FPS between controllers pose a significant workload and effort onto ATCT facilities not directly related to controlling aircraft as FPS have to be printed, inserted into strip holders, and handed to the responsible controller. After completion of operation in the facility the strip is collected for quality control, must be counted, and stored. In addition the strip has to be handed over from tower to TRACON normally performed via air tube or via special scanners, which scan the image in the tower cab and print a new strip in the TRACON. Often multiple scanners are used to select the destination flight strip printer in the TRACON.

Quality Control Functions

Beside supporting the control of aircraft the FPS are also used by quality control to provide traffic count, by Air Traffic Control instructors to correct trainee mistakes, and by NTSB to aid in accident investigation.

Transitioning to Electronic Flight Strip Displays

Manning (1995) comes to the conclusion that utilizing an electronic flight strips display will improve controller performance and cognitive processing because EFS will reduce workload by assuming much of the associated activity of updating and maintaining flight progress information.

Changing the operation of air traffic control to omit paper strips and switch to electronic means has a history going back more than 10 years. However, implementations have mainly been fielded in the enroute domain (e.g. FAA programs URET and ATOP). In the ATCT domain implementations so far have been rare due to the lack of sufficient products on the market that can provide the performance demanded by the ATCT operation. ATCT operations require fast interaction with FPSs. FPSs have a life time of a few minutes per controller rather than 15 to 20 minutes in the enroute domain. Different approaches have been considered for Electronic Flight Strips (EFS).

- Radar label / data block
- Tabular flight strips (on radar or auxiliary screen)
- Metaphoric animated strips

Although possibly feasible for other Air Traffic Control domains the radar label/data block presentation as well as tabular flight strip displays are not suitable for ATCT operation as they do not support the flexibility needed by controllers to perform a wide variety of preplanned and unplanned operations.

EFS operation on metaphoric animated strips has proven the alternative of choice as the close interpretation of paper strips into electronic means does not negatively impact a controllers operation, rather enhances his ability to perform operations. Products such as the Frequentis implementation smartStrips provide a wide variety of automated features, which greatly increase efficiency of operation, reduce cost and increase safety.

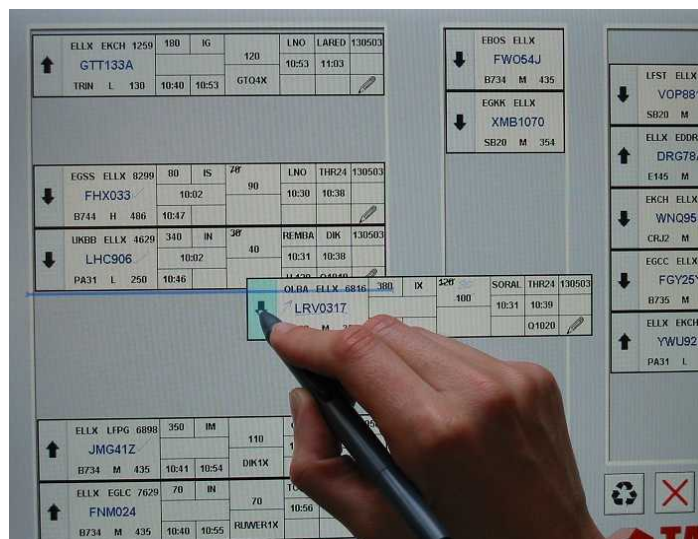


Figure 1 smartStrips is an Intuitive Electronic Flight Strips System Contributing to Increased Safety and Efficiency

Benefits for Controllers, the NAS and the Aeronautical Community

Electronic Flight Strips are a clear next step in the evolution of air traffic control into the new National Airspace System and NGATS.

One Strip per Flight and Controller

Each time a parameter is updated by the flight data computer a new paper strip is printed for the controller. This leads to multiple FPS for the same aircraft, which have to be coordinated, relevant pieces of annotations have to be transferred, and the outdated FPS has to be discarded. EFS eliminates this repetitive procedure 100%. Information history is managed within the EFS system and can be retrieved either as a history information field on the electronic strip itself or in the logging feature of the EFS system.

Automatic Strip-bay Size Adjustment to Traffic Volume

Workload in an ATCT varies widely during the course of the day. In the EFS system the strip bay can be (automatically) adjusted to accommodate varying traffic volume. Additional “waiting strips bays” can display additional strips in a reduced format. Pavet (2001) demonstrated in a field study that in fact a very small part of the displayed information is actually required for “waiting strips”. The EFS allows a new way of organizing strips in such a more efficient way. The graphical user interface of the system can for instance limit the number of strips to the immediately important strips.

Intuitive and Efficient Data Entry

In the EFS system the controller is able to mark the strip to enter clearances corresponding to actions as push-back, taxi, line-up and take-off. Using an EFS system, which mimics the paper strip on a touch entry display provides an intuitive and efficient strip marking without the need for keyboard/mouse.

Clear and Legible Strip Markings

Marking strips in a clear and legible way is mandatory for a fluent and secure workflow. Providing most markings and annotations via electronically printed text ensures this.

Free Hand Annotations

Free hand annotations are an important aspect that allows controllers to effectively manage situations, which are not considered “standard” and are therefore not predicted by the workflow management of the EFS. A fully suitable EFS system takes this into account and allows the controller to perform free hand annotations. These markings remain on the strip even as it is moved to another position.

In Conclusion

Electronic Flight Strips (EFS) are well on the way to replace the current paper strips. However, EFS have to do more than adequately replace the paper strips. They must add functionality rather than reduce information and flexibility. The controller uses flight progress strips as a workflow tool. It is commonly agreed that EFS does provide enormous benefits to the controller if design properly. EFS must accommodate the operation of the ATCT, reduce the workload of the controller, and increase his situational awareness. With the introduction of EFS an increased level of efficiency and new safety enhancing functions can be expected.

References

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