Procedure Design Documentation Lifecycle Requirements

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In the very near future, as the aeronautical information community races toward automation both on the ground and in the aircraft, the separation between procedure design, flight inspection, and charting will disappear. The goal of this paper is to provide a call to the International Civil Aviation Organization (ICAO) to mold the process of documenting instrument procedures into a seamless information stream from front-end procedure design through flight inspection, charting, and returning to procedure design for maintenance. As we rapidly track inbound toward the implementation of the Global Navigation Satellite System (GNSS) in the international aviation community, there is a need to define the minimum requirements of documentation for the lifecycle of an instrument procedure whether it is developed for terrestrial or space-based navigation.

In today's RNAV environment, more data is required from and passed by the designer to the flight inspection crew and finally to the charting agency. There is a point where all agencies' requirements will intersect—albeit for a brief period. It is at this level of detail that the international community should establish minimum requirements.

As a community, we must be mindful of the capabilities of the total community, rather than just attending those who are close to full implementation and possess full automation capabilities. The minimum requirements must address the capabilities of the lowest common automation denominator, and be achievable by everyone involved in the process.

In order to identify these minimum requirements we must address three (3) core issues. First, we must answer what the purpose of procedure design documentation is from the perspective of the designer. Next, we need to identify the minimum common requirements for flight inspection aircrews to evaluate the instrument procedure satisfactorily. Finally, we must ensure the necessary information about a design is provided to the charting agency responsible for graphically depicting the procedure to the aviation community.

Not every ICAO signatory State is able to put together a slick documentation package with color graphics and every conceivable data element in a relational database. Most likely, the minimum requirements will, at least for the near term, be completed by some States entirely on paper. Those States with automation capabilities can and will define these requirements as fields in their databases. The establishment of a minimum requirement does not preclude any State from requiring more data than the standard, but rather provides a baseline all can achieve, and from which all may work to ensure the safety of flight and protection of this critical data.

Now is the time for an international consortium of designers, flight inspectors, charting services, and those responsible for providing international aeronautical information services to team together under the auspices of ICAO to identify where the data requirements intersect and to publish minimum standards and recommended practices for the lifecycle documentation of instrument procedures.

INTRODUCTION

"The object of the aeronautical information service is to ensure the flow of information necessary for the safety, regularity and efficiency of international air navigation. The role and importance of aeronautical information/data changed significantly with the implementation of area navigation (RNAV), required navigation performance (RNP) and airborne computer-based navigation systems. Corrupt or erroneous aeronautical information/data can potentially affect the safety of air navigation."[1]

Automation in and outside the aircraft is becoming a way of life. As the world of aviation moves towards the implementation of future air navigation systems or FANS, it is becoming more dependent on computers. Just as today's flight decks are dramatically different than those of the early aviation pioneers, so have we progressed in the use of navigation systems. Gone are the days of aeronautical ground lights guiding the way for a pilot. When was the last time you heard a pilot refer to flying IFR as *"I FOLLOW ROADS"*? Today's navigation systems also require a shift in how we look at procedure design documentation, from its inception through flight inspection, charting, and publication into State AIPs, full circle to the maintenance phase.

[1] International Standards And Recommended Practices Aeronautical Information Services, Annex 15 To The Convention On International Civil Aviation Tenth Edition — July 1997 Amendment 31, Chapter 1 Introduction

There are many defined standards within the guidance of ICAO, but little or none on how, where, or what to document about the history of an instrument procedure's development. Everyone with whom I have spoken recently has a different method of documenting their procedure design data; some use simple numbers on a form, while others use complex, computer-driven applications. No one system is categorically better than another; they are just *different*. I am not championing a particular methodology, but I am searching for consistency.

Herein lies the key point of this paper: I challenge the international aviation community and ICAO to define a minimum standard of documenting instrument procedures sufficient to support these procedures through their entire lifecycle.

DOCUMENTATION REQUIREMENTS FOR PROCEDURE DESIGN

From my perspective as a procedure designer, I feel all of the information influencing the initial design should be documented. A simple diagram tells only part of the story. What criterion was in force at the time of the design? Why was a certain track or radial selected over another, more aligned with the runway centerline? Did the designer intend for a leg to be a direct-to-fix or track-to-fix leg? Was the fix designed to be a fly-over or fly-by fix?

What external sources played a role in the design? Did Air Traffic Control request a certain track for separation or convenience? What was the source of the data used, were there coordinate transformations made, and if so how were the transformations accomplished? What software, if any, was used in the design process and what version of the software was used? These are some of the questions the procedure designer should document so later, when the procedure needs to be maintained or updated, there is no doubt why the procedure was designed in the manner it was.

Why do I feel the need for documentation so strongly? I have had to maintain or validate other designers' work. Without documentation that includes this information, I always have questions. While what the designer did was technically correct and met the requirements of the criteria, there always seem to be questions remaining. In most cases I am able to answer these questions by discussing the procedure with the original designer. But in some cases I can't, so I have to simply accept there was a valid reason he or she selected a radial not aligned with the centerline, or didn't use a step-down fix to achieve lower minimums. For some choices, I can make an educated guess about what the original designer was thinking. Possibly it was to avoid an obstacle or to move an obstacle into the secondary area; maybe it was to meet an air traffic requirement. Other influences are more of a mystery. Exactly what criteria was in force at the time of design? Did the designer have the most current version of the criteria? Without documentation identifying these types of information, there will always be questions.

In my own work, I write everything down. When I come across an obstacle posing a problem for the procedure; I write down what the problem is and why I chose the course of action to overcome the problem in the design. I then type these notes (sometimes they are simple drawings) into a document I include with the procedure. Later, when either the client or a colleague has to update or maintain the procedure, they know what I did, why I did it, and what rule I used to ensure it was a safe thing to do. My sucessors will also be able to determine why I took a particular course of action, such as raising the glidepath angle instead of raising the decision altitude. Why did I choose to accept a small missed approach climb gradient over raising the Minimum Descent Altitude? What values did I use for vegetation and how were those values determined?

Vegetation, by the way, is one point I believe is overlooked in most of the procedure design documentation I have reviewed. Unlike man-made obstacles, trees grow. I want to know the original designer considered this factor in his or her design. Did the designer use the vegetation's full-grown height and if so, how did he determine that value? Did he define a maximum height the trees at a certain point in the procedure could attain, and instruct the airport operators to keep them trimmed at or below this level?

PROCEDURE DESIGN DOCUMENTATION FOR FLIGHT INSPECTION

Since flight inspection is an in-flight review of the entire procedure, the data elements required include, but are not limited to, those needed to accurately define the flight paths, protection areas, and the obstacles dictating the minimum altitudes. Accurate mapping supporting the design is key to the flight inspection crew's identification of obstacles. These elements need to be communicated from the designer to the flight inspector so the procedure can be validated appropriately and efficiently. Documenting this type of information with a procedure design provides the flight inspector with insight on exactly how and why the procedure was designed and what are the critical elements.

Is this type of information critical for the flight inspector? Most likely not. However, the inspectors I have talked with often review procedures in-depth before they go flying so they can optimize their flight time, and if my notes help in this process, great. Does every inspector take the time to review my notes? Probably not. But if they did, I believe they would be better equipped to provide the validation of the procedures and ensure the procedures are safe and efficient.

Some States require the designer accompany the flight inspector on the validation flight. There are some pro and con issues with this philosophy. On the *con* side, if the designer is accompanying the flight inspector, the designer is not completing a design for another aerodrome. On the *pro* side, however, if the designer sees the procedure from the aircrew's perspective, he or she gets a new perspective on what is happening at certain points of the procedure on the flight deck. This perspective leads to better procedure designers and ultimately, to better procedures. Additionally, a designer on the flight deck can assist the flight inspection team in obstacle identification. Why was a certain tower or ridgeline *not* chosen, even though it appears higher than the selected obstacle? The designer's insight into the design and topography can assist in the flight inspection process.

Can this information, passed on in the procedure design documentation, achieve the same results? It would go a long way towards the goal. That's why I'm proposing a minimum requirement for such documentation. Would a policy requiring, or at least recommending, the designer participate in the inspection be *too* stringent? I do not believe so. In fact, with a designer and a computer on-board, any identified adjustments or corrections could be fixed real-time and the procedure validated, without having to return it to the designer for correction and then re-inspection at a later time, as is most likely the case now. Our current system results in delays to the publication of procedures and additional aircraft and crew costs.

PROCEDURE DESIGN DOCUMENTATION FOR AERONAUTICAL INFORMATION SERVICES CHARTING AND NAVIGATION DATABASES

In today's computer-driven flight decks, the database is a key element of navigation. The introduction of RNAV instrument procedures requires more information be passed from the designer to those responsible for publication and database coding. Gone are the days of providing a simple drawing defining the locations of the navigational aids, the radials and distances used, and any special circumstances needing to be addressed. Today's RNAV procedure designs require each leg type and fix type be noted so they can be appropriately coded.

This is where the lack of documentation becomes most evident. Since navigation database suppliers extract their information from the official sources provided by the State, if the information is not accurately and completely defined in the source, the database suppliers cannot appropriately code the procedure into the navigation database. Instead, they must first validate the information they have. In most cases information can be validated through a phone call, letter, fax, email, or by applying the standards outlined for aeronautical information, such as what leg types can precede or follow other leg types. But why waste time hunting down information that could have been included in the first place? If this information were passed in some form to the AIS-responsible authority and published accordingly, it would allow the charting and database suppliers to more easily and quickly produce the required products.

WHAT INFORMATION TO DOCUMENT

Every State seems to do documentation differently. The United States has specific forms with exacting guidelines for documenting their instrument procedures. On the other end of the spectrum, most other States I have discussed the issue with have little or no guidance on what to include as documentation for the instrument procedure. There are always going to be States requiring every possible data item be addressed and stored in a relational database for retrieval at a moment's notice. Is this the appropriate answer for all parties? I do not believe it is, because not every State has the capability or the requirement to provide maximum data.

We as a community must be cognizant of the capabilities of every State. We must consider not just those with advanced computer systems and large staffs, but also the small states with a single international airport and possibly a single designer. We need to define what information must be passed from the designer to the flight inspector, to the charting and navigation database suppliers, and define it as the minimum standard. We must include the information required to support the procedure throughout its lifecycle, including maintenance by a third party. Not only will such a standard provide the required documentation to update or maintain a procedure, it will also be an invaluable tool in reconstructing a procedure if there ever was an accident, by providing investigators with answers to questions.

The standard needs to define the absolute critical elements, track the source of the information, identify the criteria used and provide documentation of these elements. My examples do not exhaust every critical element, and my purpose here is not to define all the key elements to be included in such a standard. I am simply calling on ICAO and the aviation community as a whole to get together and define a standard for the good of the whole.

CONCLUSION

Does this require years of study and coordination to accomplish this task? No. Does it require the attention of ICAO? Yes, because it is a global issue affecting all of the contracting States. Should a study group be formed to make recommendations to ICAO? Most definitely, but it needs to be a group comprised of members of all the responsible parties from procedure designers, to flight inspectors, to AIS personnel, to members of industry such as charting and navigation database suppliers with a clearly defined mission statement and recommendation timeline. Can this situation be addressed easily without imposing large additional requirements on the process? I believe yes, and it is something we as a community need to do together. Finally, the standard needs to be simple, economic of time and resources and flexible enough to support navigation using terrestrial or space based navigation. This concerns all of us. It shouldn't be difficult, but it is vitally important. To borrow a phrase from Nike (tm) "Don't think about it, Do it". We're already late, now is the time to address the issue and now I'm asking everyone who reads this to join me in calling for action on the part of ICAO in this matter.