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From avionics to aviation information architecture

On March 27, 1977, around 17:05, a KLM Boeing 747 was about to depart from Tenerife Airport at Canary Islands, off the West African coast. Many planes were queuing to take off and it was foggy. The pilot repeated to the tower the instructions that he had just received: 'We are cleared to the papa beacon, climb and maintain flight level 90 until intercepting the 325.' Then he said: 'We are now at takeoff.' The tower replied: 'OK...Stand by for takeoff. I will call you.' During these last two short sentences there was a squeal on the line. The KLM plane sped up on the runway, where a Pan Am 747 was still taxiing after landing. The two 747s collided and 583 people died. It is still the worst accident in aviation history.

As often, the accident was probably caused by a combination of factors. It was foggy, so the pilots did not have an overview of the runway. There was pressure on the pilots to leave quickly because weather conditions would grow worse again and all planes were late already; the chief KLM pilot was convinced the runway was free, but his co-pilot was not, etcetera. But in this case miscommunication was probably the main factor causing this tragic incident. The KLM pilot's native language was Dutch, the controller's native language was Spanish; they were talking in English over a radio with squeals and in very noisy surroundings, especially the pilot. With the sentence 'We are now at takeoff,' the KLM pilot meant 'We are taking off'. The controller in the tower understood that the plane was standing still at takeoff point. Collision because of linguistic ambiguity.

In his book *Fatal Words – Communication Clashes and Aircraft Crashes*, Steven Cushing points out that many airplane crashes are caused by miscommunication (which he classifies in linguistic terms) and proposes improvements such as an intelligent voice interface and a visual interface. In the Tenerife accident, a visual runway information system might have shown to the controller, the KLM pilots and the PanAm pilots the presence of an airplane taxiing on the runway and an aircraft speeding up at the take off point. Visual presentation of this information could very well have prevented this horrible accident.

Since those days, presentation of information has evolved strongly. Developments in avionics now already make a much more visual presentation possible and much more can be expected in the near future. Indicating lights on runways working together with information presented in the airplane, head-up displays in airplanes, panoramic night vision goggles, 3D visualizations, animated perspectives, high resolution multi-function displays that replace numerous electromechanical dials – the technology is there to get all the necessary information to pilots and controllers in highly visualized ways.

However, having the technological products does not necessarily mean that these are always applied in the best possible ways. In aviation, cooperation between researchers from various fields is vital and quite common. When it comes to communication, for instance, electronics engineers, software programmers and ergonomists or

psychologists specializing in human factors are all engaged by the aviation industry and research institutions. Pilots and controllers are also intensively involved in these research projects. A lot of study is done to find out what information should be presented to whom and at what moment. Moreover, much research is done to find out *how* all this information is best presented.

The question that interests us here is who is involved in the visualization of information – and who is not. Of course, the electronics engineers and programmers that make the technology possible are involved. So are psychologists and ergonomists who study how humans perceive and cognitively process information – what pilots can detect, make out, and how much information they can handle in a certain period of time or at the same time, what colour or size differences can best be discerned on a certain type of screen, etcetera. But a short survey over the Internet and a virtual trip along information desks and individuals working in companies and research institutes specialized in avionics indicates a remarkable lack of certain other specialists: those specifically educated in the visual presentation of information, such as graphic designers, information architects, visualizers – and researchers in this field. The same seems to be the case in other highly specialized technical fields, such as medical technology: specialists trained in visualizing are hardly involved at all.

It requires interest in technology, intelligence and an investment in time to bridge the gap between complex technology like aviation, and the visual presentation of the information that such technology produces. Some ergonomists have been able to apply their gamma-knowledge in the beta-domain. But it seems that very few information designers have been asked to apply their skills and knowledge in information visualization to aviation technology. That is certainly a pity, because aviation can be very challenging for information designers and visualization researchers. Ergonomists specializing in communication may set frameworks, they may do important

testing, but information designers may better be able to produce visual presentations that are both aesthetically and effectively well balanced.

This special issue on information presentation in aviation, shows information designers some issues concerning the presentation of information in aviation. We invited avionics engineers and ergonomists to write articles about information presentation in aviation. None of them is trained in graphic or visual design. We have tried to guide these authors to write for information designers who are not especially informed about aviation and we think that they have done a good job.

Graphic designers have played a role in information presentation in aviation before. For instance, cartoonists tried to make the training documentation for fighter pilots during World War II more attractive to read (Figures 1 and 2. From Westendorp, 2002). The Walt Disney Company produced movies in which their characters played a role in explaining the use of aviation and military technology to fighter pilots. In a 16mm film, for instance, Mickey Mouse explains the use of the machine gun.

As far as aviation documentation is concerned, the role of cartoonists has mainly been to make it more attractive to read. If information architects want to get involved more generally in the aviation user interface design, they will have to invest time and beta-brainpower to bridge the gap between information design and *the other culture*.

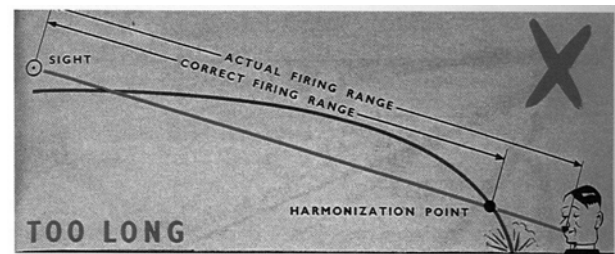
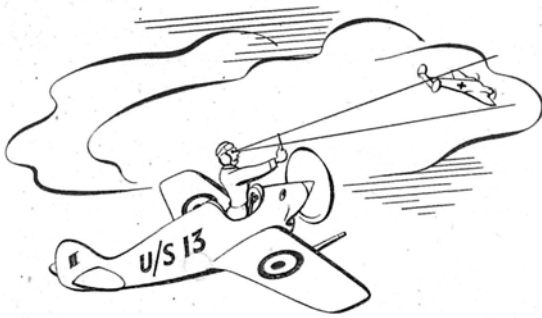


Figure 1. Illustration from a training manual for World War II fighter pilots: detecting ring range (*Bag the Hun*, 1943).



This method is definitely dated

Figure 2. Illustration from a training manual for World War II fighter pilots: establishing the distance (*Bag the Hun*, 1943)

In this issue

Four articles deal with the issue of information design in aviation, from very different lines of approach. We have asked the authors to address information designers and present overviews of their aspects of the information areas, but of course they also have their own stories to tell. It is up to the readers of the thematic articles in this issue to draw conclusions and generalizations concerning the possibilities that information design can offer and could have offered. Discussions are welcome on our discussion group InfoDesign-Café (for subscription, see www.InformationDesign.org); we may well publish parts of a thread about this in a next issue of the IDJ. Especially interesting are opinions about the *motivation* for the visual design choices.

We hope that the selected articles give a good idea of some of the problems that information designers in aviation have to solve – and the ways avionics engineers, software programmers and ergonomists have done that now.

Theunissen & Etherington (*Computer graphics in the cockpit*) discuss the state of the art in 3D computer graphics in relation to the graphics used in today's flight displays. They show how system requirements, properties of

the display, image generation capabilities and current practices in the cockpit and in the tower all have their influence on the design of information. In the second half of their article, they present their design rationale for a synthetic vision display that they have developed.

Ort (*Displays in air traffic control*) presents an overview of technical possibilities and how the limits and security standards regarding data transmission influence the design of the information. He presents the concept and design of a standardized screen interface for interaction between pilot and controller.

Kessler and Knapen (*Designing for future advanced controller displays*) focus on new ways to present information to air traffic controllers. They discuss the introduction of a digital communication channel between pilot and ground instead of voice communication as is currently used. For information designers it is interesting to notice the introduction of Windows-like information in a situation where radar screens and radio are common.

Kroft and Wickens (*Large quantities of related information presented on relatively small displays*) discuss the problem of presenting a lot of (dynamic) information on a limited display. What is the better way to present continuously changing air navigation information and continuously changing air hazard information): as an integrated display or separated? This choice has effects on the way the information is scanned, on the user interactivity, on clutter and on the display size.

Illustrations can be found in colour in the electronic edition and a selection is reproduced in colour in the Colour Plates section in this issue.

References

- Cushing, Steven (1994). *Fatal Words: Communication Clashes and Aircraft Crashes*. Chicago & London: The University of Chicago Press.
- Westendorp, Piet (2002). *Presentation Media for Product Interaction*. Delft: Delft University Press.