

## **TEN YEARS OF HUMAN FACTORS IN AIR TRAFFIC CONTROL**

**Bert Ruitenberg**

**Human Factors Specialist**

**The International Federation of Air Traffic Controllers' Associations**

When I was invited to present a paper on 10 years of Human Factors in Air Traffic Control I initially was determined to specifically include the years 1951, 1961, 1976, 1977, 1991 and 1994 in my presentation, which left me with the task to only find four other years worth mentioning. After some reflection though I realised that the intent of the Symposium organisers was for me to focus on the decade preceding today's date. Of course I'm more than happy to restrict my presentation to that period, but in a sense the restriction imposed by the title of this paper suggests that there only have been Human Factors efforts in ATC for the last ten years. I would argue that that is not exactly true, and the selected years I mentioned earlier may help to prove this point.

1951 is the year in which a group chaired by Mr. P.M. Fitts in the USA produced a report on "Human Engineering for an Effective Air Navigation and Traffic Control system". 1961 is the year in which The International Federation of Air Traffic Controllers' Associations (IFATCA) was founded, by Air Traffic Controllers' Associations from 12 European countries. 1976 is the year in which a mid-air collision occurred over Zagreb, Yugoslavia, and in 1977 there was a collision between two Boeing 747s on the runway of Tenerife, Canary Islands. The investigations of those two accidents addressed many aspects of Human Factors in ATC. In 1991 IFATCA became involved in the ICAO Flight Safety and Human Factors Programme. Last but not least, in 1994 ICAO included in Annex 1 (Personnel Licensing) the requirement for Air Traffic Controllers to "have demonstrated an appropriate level of knowledge in the subject of human performance and limitations relevant to Air Traffic Control".

So despite the fact that the subject of Human Factors in ATC has been on the agenda for almost fifty years now, in this presentation I will confine myself to the developments that occurred over the last ten years. Of course I will in particular address the role of IFATCA in those developments, but I hope to also give you an idea of what is happening in the field in a general sense. Here is an overview of this presentation:

- IFATCA's role in the ICAO Flight Safety and Human Factors Programme
- IFATCA's role in other Human Factors forums
- IFATCA's Human Factors activities in general
- Human Factors in Air Traffic Control: achievements
- Human Factors in Air Traffic Control areas with room for improvement
- Conclusion

### **IFATCA's role in the ICAO Flight Safety and Human Factors Programme**

The 1990 Leningrad Seminar marks the start of the ICAO Flight Safety and Human Factors Programme. At that time IFATCA was not yet involved in the ICAO programme, but to their credit the seminar organisers had included in the programme several presentations on Human Factors in ATC. None of those presentations involved active Air Traffic Controllers though. There were however a number of active Air Traffic Controllers in the audience at Leningrad, and their reports of the seminar did reach IFATCA. When ICAO embarked on its first series of Regional Seminars, with Doualla (Cameroon) as the first venue, IFATCA again was not directly involved. But at the second stop of this first series, in Bangkok (Thailand) in November 1991, the then Executive Vice-President Professional of IFATCA, Mr. Wim Rooseman, presented a paper on Human Factors in ATC. From that point onward IFATCA has been an accepted member of the small faculty of lecturers at the ICAO Regional Seminars. We presented papers at every subsequent seminar of the first series, with the exception of the Panama-seminar in November 1997. When ICAO began its second series of Regional Seminars, in Hong Kong (1995), ATC had been left out of the programme by intent so IFATCA was not participating there. But in response to feedback from the audience this omission was rectified and at the next seminar, held in Abidjan (1996), IFATCA again was included as a faculty-member. This membership

was continued at the seminar in Beirut, last December, and is expected to also be valid for the seminar that will be held in West-Africa later this year. IFATCA furthermore presented papers at the ICAO Global Symposia in Washington (1993), Auckland (1996) and now in Santiago de Chile.

In parallel with those activities, IFATCA has been a member of the ICAO Flight Safety and Human Factors Study Group since 1991. Highlights of our involvement are the submission of a detailed review of the draft-version of Human Factors Digest no. 11 (Human Factors in CNS/ATM systems), editing the ATC-chapters of the recently published Human Factors Training Manual, and participating in the group's review of existing ICAO Annexes and Documents with the aim to incorporate Human Factors requirements. IFATCA's role in other Human Factors forums.

As what I consider to be a direct result of IFATCA's involvement in the ICAO Flight Safety and Human Factors Programme, we are regularly invited to present papers at other Human Factors events around the globe as well. Examples are Aviation Psychology Symposia in Columbus, Ohio (USA), and in Manly (Australia). We presented a paper at the IATA 22nd Technical Conference (Montreal, 1993), at the 21st Conference of the European Association for Aviation Psychology (Dublin, 1994), and at workshops hosted by Eurocontrol. IFATCA was also involved in a panel as part of the conversion-training programme for Australian Air Traffic Controllers in preparation for the implementation of their new automated ATC-system.

Common factor in all those presentations has been to demonstrate that most of the Human Factors knowledge derived from studying the flight deck or aircraft design and operations can be transposed to the ATC domain. It is important to realise though that identification of similar problems in both domains does not necessarily imply that the solutions from one domain can be successfully applied to the other domain too. In most presentations made, IFATCA tries to propose solutions for ATC Human Factors issues. Such solutions are usually based on available IFATCA Policies.

### **IFATCA's Human Factors activities in general.**

In the list of significant years for Human Factors in ATC at the beginning of this presentation I included the year in which IFATCA was founded (1961). This event may seem to be a little out of place when compared to the other events from the list, yet it isn't. The words used by the ICAO Air Navigation Commission in 1986 to formulate the objective for the Flight Safety and Human Factors Programme are: "To improve safety in aviation (...) through the provision of practical Human Factors material and measures developed on the basis of experience in States, and by developing and recommending appropriate amendments to existing materials in Annexes and other documents with regard to the role of Human Factors in the present and future operational environments". Now if we substitute "Human Factors" by "Air Traffic Control" in this statement, we get a rather accurate description of the aims of IFATCA as formulated 25 years earlier!

Since its foundation in 1961 IFATCA has developed Policies on a wide range of technical and professional topics. Our representatives in international meetings use these Policies to prepare their input to the meetings. Such meetings comprise ICAO panel-meetings as well as those of Regional bodies, like for example the European ATC Harmonisation and Integration Programme (EATCHIP) and the African Civil Aviation Conference (AFCAC). By providing input based on the IFATCA Policies, our representatives participate in "developing and recommending appropriate amendments to existing materials in Annexes and other documents with regard to the role of Air Traffic Control in the present and future operational environments", which is in keeping with the spirit of the words from the Air Navigation Commission.

The difference is that the ICAO Flight Safety and Human Factors Programme is attempting to apply theoretical knowledge in practice, whereas IFATCA's efforts are to convert practical expertise into written procedures, rules and regulations. In other words, the ICAO programme follows a top-down approach and IFATCA uses a bottom-up approach. But the important thing is that our aims are largely the same.

The IFATCA Policies are developed by Air Traffic Controllers for Air Traffic Controllers, and without exception address areas that can be described as the interfaces of the well-known SHELL-model. A good example to illustrate that the aims of the two organisations are similar is IFATCA's Policy on Automation. At

the 1991 IFATCA Annual Conference a number of separate Policies were adopted that can be summarised as follows: "Automated systems are there to help the Air Traffic Controller, not the other way around". Without intending any disrespect, I submit that this statement also epitomises the principles of Human Centred Automation as described by Dr. Charles Billings that same year. ICAO later adopted those principles to guide the development of the CNS/ATM-system.

Continuing with the top-down/bottom-up metaphor for just another moment, I think the approaches by IFATCA and ICAO came together in 1991 when we became involved in the Flight Safety and Human Factors Programme. Allow me to take this event as the starting-point for an overview of what has been achieved since then.

### **Human Factors in Air Traffic Control: achievements**

From a high-level perspective the achievements are twofold: Air Traffic Control was put more prominently on the Human Factors agenda, and Human Factors has received more attention within the Air Traffic Control community. So now let's lower our perspective and take a closer look at some examples to illustrate these points.

#### **ATC as an item for the Human Factors community.**

In previous decades topics on Human Factors in ATC were predominantly covered by scientists and researchers who specialised in this field. Although they would make extensive use of field-studies and analyses of selected simulator-exercises involving qualified Air Traffic Controllers, their work was mainly academic in nature. Favourite subjects for research were task-analysis and job-description of Air Traffic Controllers, with development of selection-methods also very much in the foreground. Notice that these subjects have little direct practical value for already qualified Air Traffic Controllers.

But during the last decade we see a development in the scientific community to conduct research in ATC that is aimed at a more practical application of the results. The realisation has grown, and continues to grow, that the aviation-system does not consist of isolated units but is a complex socio-technical system with interactions at many levels. The improvements and benefits brought by scientific research to the airborne part of the system are considerable. But there is a potential for even more improvements and benefits to the system as a whole by applying similar efforts to the ground-based parts of the system. It is this potential that now motivates researchers to look into the interaction between the flight deck and the ground, i.e. maintenance, airline dispatch and ATC. Examples of these efforts are the USA's Panel on Human Factors in ATC Automation, chaired by Dr. Christopher Wickens, and the work on whether or not Automation can enable a co-operative future ATM system, by a group of researchers from universities in Ohio and Illinois comprising Drs. Phil Smith, Charles Billings, David Woods, Elaine McCoy, Nadine Sarter, Rebecca Denning and Sydney Dekker. The work from those and other groups will in the near future undoubtedly have a bearing on the working-practices of already qualified Air Traffic Controllers.

#### **Human Factors as an item for the ATC community.**

Modelled after the set-up of the ICAO Flight Safety and Human Factors Programme, IFATCA held an internal campaign to increase the awareness among its membership of the importance of Human Factors in aviation in general and in ATC in particular. Articles were published in the Federation's quarterly magazine "The Controller", and a dedicated Panel was introduced as a standard-item at the Annual Conferences from 1993 onward. In this Panel speakers were invited to address the Conference on selected Human Factors issues related to ATC. Furthermore, IFATCA organised a number of Regional Seminars for its Member Associations in which technical issues as well as related Human Factors issues were addressed.

In Europe the EATCHIP Human Resources Team does a lot of valuable work for the practical application in ATC of Human Factors knowledge. I specifically would like to mention the production of several little booklets, called Human Factors Modules, and the work done on the development and implementation of CRM-courses for Air Traffic Controllers, called Team Resource Management (TRM) courses. The

implementation of TRM will potentially have a direct effect on the working-practices of already qualified Air Traffic Controllers in the 32 European States that are co-operating in EATCHIP. But also on the regulatory side there are significant achievements to report. As already mentioned, in 1994 ICAO included a requirement in Annex 1 that applicants for an Air Traffic Controller's licence must have demonstrated an appropriate level of knowledge in the subject of human performance and limitations relevant to Air Traffic Control. Most States or organisations that train their Air Traffic Controllers in accordance with the requirements from Annex 1 have by now incorporated this subject in their curriculum.

A second and related achievement by ICAO is the production of the Human Factors Training Manual, published in 1998. This Manual is an edited compilation of the earlier Human Factors Digests, and as already mentioned in this presentation IFATCA was responsible for editing the chapters on Human Factors in ATC. What should be realised however is that these regulatory efforts will mainly affect students who are entering basic ATC-training. For the already qualified ATC-workforce a different approach will be required. The regulatory framework as provided by ICAO admittedly will allow such a different approach, but the true enablers will have to come from the regulatory bodies in States.

### **Human Factors in Air Traffic Control: areas with room for improvement.**

One of such enabling factors could be the institution of periodical Recurrent Training-schemes for Air Traffic Controllers, possibly as element of an ATC Proficiency Checking system. Although there are a few countries where these schemes and systems exist, the vast majority of Air Traffic Controllers in the world are never subjected to any formal training or checking after they have obtained their licence, except maybe when new technology is introduced at their facilities. The result of this lack of periodic training-programmes is that there are no convenient opportunities embedded in the ATC-organisations to teach Air Traffic Controllers any new knowledge or skills during their career. Any training-programme for already qualified staff that is contemplated will have to be planned as an extra to all other ongoing activities, and is therefore often regarded by many Air Traffic Services-providers as a luxury the organisation can't afford.

This line of thinking could quietly persist in the industry for many years because the provision of Air Traffic Services (including ATC) and the Regulatory role were both in the hands of the State. But in this last decade there is a marked development in the industry to separate those roles. The State retains its role as Regulator but the provision of Air Traffic Services is delegated to some form of privatised or corporatised agency with a large degree of independence. This leads to a situation where the Regulator can treat the ATS provider the same way as they treat the Airlines in that State. That is, assuming the Regulator possesses the required amount of in-house ATS-expertise for that role, which is something that in some cases appears to have been overlooked.

To summarise this point, it is IFATCA's view that if more States were to introduce Recurrent Training programmes for Air Traffic Control staff, these could be useful platforms for the gradual and systemic introduction of Human Factors knowledge to already qualified Air Traffic Controllers.

A second subject where improvements are possible in the industry at large is ATC Incident Investigation. Similar to what was said before about the lack of recurrent training and proficiency checking programmes in ATC, there are few States that structurally investigate ATC incidents. And in several of those who do, it could be argued that the investigations are conducted mainly with a view to apportion blame. IFATCA thinks that if ATC incidents were structurally investigated in a non-punitive environment with the aim to find and correct systemic weaknesses, the safety of the air navigation system could be significantly enhanced.

A further and perhaps more delicate area with room for improvements are what we call the safety-related working conditions of Air Traffic Controllers. Hours of work, consecutive working-days and mandatory overtime all have a direct bearing on safety if they are such that they may lead to fatigue. Even remuneration could be included in this category, for if a Controller's wages are insufficient to buy food and pay the rent this Controller is forced to take a second or even third job in order to survive. It requires little imagination to see that fatigue could easily occur in those cases. There are many places in Asia, Africa and South America where Controllers are in continual danger of becoming fatigued for those very reasons. But this problem is

not confined to these continents. With the ongoing corporatisation of ATS-providers there are signals from the ATC-communities in Europe, North America and the South Pacific that the goals of the new organisations are subject to a subtle shift when compared to the old ones.

Traditionally, the goal of ATC has been to provide a safe and orderly flow of traffic. But now that ATS is being corporatised we see the concept of an "economical service-provision" emerge. In other words, the costs as well are becoming an important factor for the organisation. This inevitably seems to lead to a situation where everything and everyone in the organisation is pushed to the legal limits. And although the Regulator intended those limits as a minimal requirement, they by default become the standard in the organisation from which no deviation in either direction is possible, thus removing whatever internal flexibility the organisation had.

If this results in an increasing occurrence of "burn-out" symptoms in the workforce, with an increase in the attrition-rate of the staff to match, the organisation will come out weaker than before which in turn could have a negative effect on air safety. IFATCA therefore urges all ATS-providers to invest in their human resources rather than to consider them as an opposing force.

Earlier in this presentation I mentioned the concept of Human Centred Automation of which IFATCA thinks it is the way for the future. For ATS-providers a similar yet still undeveloped concept of a Human Centred Organisation may well prove to be the key to longevity. An organisation that makes a lot of money in a short time but loses its entire staff on the way will cease to exist. An organisation with dedicated and motivated staff on the other hand will potentially continue to produce revenue for years on end. Proper working-conditions and adequate recurrent training programmes are prerequisites for becoming such an organisation. They furthermore are prerequisites for an organisational culture that fosters attention for Human Factors.

The final area with room for improvement that I want to mention in relation to Human Factors in Air Traffic Control is the Free Flight concept. Much has been said about this topic, also by IFATCA-representatives at dedicated meetings or conferences, and I prefer to not repeat all that here. Our point is that Free Flight is a highly technology and economy driven concept, with little regard for Human Factors. Despite the fact that almost none of the assumedly required technology is implemented or even available yet, the industry seems convinced that Free Flight is the desired end-state of all future developments in air navigation. This conviction appears to be especially strong among the non-operational people in the industry, i.e. the policy-makers and budget-planners, and particularly in airlines.

IFATCA does not share that conviction. On the other hand, we don't dismiss the idea of transferring responsibility for aircraft-separation from the ground to the flight deck either. But where we differ from the planners in the industry is that we think this form of autonomous flight should be integrated in the existing air navigation system rather than replace it.

The air navigation system is widely recognised as being the safest mode of mechanised transportation available to man. It could be argued that the main reason for that are the many well-developed opportunities for error-detection and error-recovery in the system. Several of those opportunities are possible by allowing for generous margins on the operational side. IFATCA will be among the first to admit that in some cases these margins may be a bit too generous, yet if the capacity of the system is under pressure of an ever increasing demand IFATCA will also be among the first to caution that decreasing the margins and completely replacing the system may not be the best solution to the problem.

The Free Flight concept undoubtedly contains elements that merit further study and development. Yet the industry should exercise caution to not be tempted by the attractiveness of so-called short-term benefits that some players keep advertising. Many of such short-term benefits are based on the extensive application of new technology in which Human Factors considerations appear not to have been given a high priority. IFATCA hopes that the industry will be wise enough to apply the lessons learned from the past.

A statement from the ICAO Air Navigation Commission from January 1999, made in a wider context, would

seem to support this hope: "Industry and States need to be reminded that SARPs cannot be developed as an instant response to new ideas or technologies but only after research, technical development, verification and validation have been completed."

### **Conclusion.**

Although Human Factors in Air Traffic Control is not a novel item, the ICAO Flight Safety and Human Factors Programme has given a new impetus to the work in this area during the last decade. One of the more significant results is that elements of Human Factors in Air Traffic Control have migrated from the academic world to the operational domain, with possibilities for direct and practical application by Air Traffic Services providers.

Yet many challenges remain to be faced. These challenges exist in the field of providing already qualified Air Traffic Controllers with Human Factors knowledge and skills, as well as in the field of the ongoing development of the Air Navigation System. IFATCA is committed to an evolutionary improvement process that builds on the strengths of the existing and proven aviation-system while attempting to mitigate the effects of its weaknesses. The application of Human Factors knowledge therefore must be an integral part of this process.

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