



## THE SIGNIFICANCE OF ERGONOMIC APPROACH IN DESIGNING WORKING ENVIRONMENT OF AN AIR TRAFFIC CONTROLLER

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### Abstract

*There are a lot of ergonomic conditions that have to be satisfied in order to ensure good working conditions at air traffic controller working environment. No surprise, considering the nature of air traffic controller duties: working hours 24/7, continuous stress, multitasking, prompt adapting to new situations, all of these being some of the factors that they have to cope with constantly. Therefore, provision of required air traffic controller task performance is a matter of good ergonomics at working environment which could affect flight safety. Therefore, quality ergonomics should be a priority in designing air traffic controller working environment.*

**Keywords:** *Ergonomics, Working Environment, Chairs, Air Traffic Controller*

## 1. INTRODUCTION

Air traffic controllers are mostly in a sitting position during their working hours. They are typically positioned in the middle or at the front of the chair with their hands recumbent on the console table where they interact with the system and the radar screen. Long sitting hours cause musculoskeletal discomfort and pain, particularly at the level of the neck, the shoulders and the lumbar tract. Some research shows that one hour of sitting in up-right, slumped, or forward leaning sitting posture led to increased discomfort at the neck, shoulder, upper back, low back and buttock [1]. In order to avoid such discomforts and health issues, ergonomic chairs are used on working positions of an air traffic controller which allow comfortable sitting posture while working, as well as useful muscle relaxation while on stand-by or resting in front of the screen.

An ergonomic chair of the good quality should be designed for forward and backwards sitting postures, adjustable in height and angle, as well as rotating and adjustable head rests. It should also have lumbar support, head rest and user-friendly controls. But chairs are not solely solution for better ergonomic working environment in air traffic control. To ensure better ergonomic environment in air traffic control, one must take into the consideration more than chairs. There are several other environment factors such as

thermal, noise, lighting, colors, of the working environment which must be taken into the consideration to ensure good working environment ergonomics for an air traffic controller.

The aim of this paper is to see what kind of requirements need to be met in order to ensure good working environment in air traffic control and to conclude, through reviewing other research, what can be done to improve working environment of an air traffic controller.

## **2. ERGONOMICS IN WORKING ENVIRONMENT**

In order to maintain safe, orderly and expeditious flow of air traffic, the air traffic controller must have a good working environment and system to interact with. Task performance depends on working environment specification and design. Throughout human-machine interactions, air traffic controller interrelates with system and controls the air traffic. Therefore, to meet all air traffic control requirements, air traffic controller working environment must be designed in accordance with correct ergonomics principles.

There are several characteristics in air traffic control working environment that need to be met in order to ensure appropriate working environment ergonomics. Some of them are thermal attributes, noise levels, radiation and visual appearance, the latter being a product of room size, lighting, the colors and surface textures.

### **2.1. Thermal environment**

Thermal environment is important for keeping air traffic controllers concentrated, comfortable and for good working environment. It usually concerns temperature, humidity and air flow. Since air traffic controller work can be classified as sedentary, recommended air temperature for reasonable comfort is between 21 °C and 25 °C [2]. Air traffic control equipment usually generates a lot of heat which needs to be vented regularly in order not to become a major source of radiant heat for the air traffic controller.

Temperature is not the only factor to keep the controller comfortable. If the relative humidity is too high or too low it can cause discomfort as well. The optimal humidity is around 50 % or slightly higher [2]. Very high humidity makes the air seem stuffy and clothing becomes uncomfortable, while very low humidity can lead to throat dryness which deteriorates the speech intelligibility and endangers the safety of flight.

The last factor of thermal comfort is air flow. The air should move in a way that is not noticeable yet sufficiently refreshing the working environment. The speed of circulating air should be 10 meters per minute [2]. Devices that generate noise, like fans, should be avoided.

### **2.2. Noise**

The main tool which air traffic controllers use in communication is speech, i. e. voice communication. If there is significant noise in their working environment it can cause decreased air traffic controller performance which could affect air traffic safety. Low

ambient noise is necessary to maintain in order to transmit accurate radio telephony communication with pilots and sector coordination. Loudspeakers are not recommended and headphones are used instead. In order to reduce ambient noise, silent air conditioners are used, along with sound absorption material like carpeting. Well-isolated working environment should decrease not only ambient noise from the working environment but also the outdoor noise like aircraft taking-off and landing. It is desirable in air traffic control environment to keep the background noise level below 55 dBA, and to suppress the noise as much as possible. [2].

### 2.3. Visual appearance

The proportion adequacy of the building, room and working environment is the first factor of visual appearance. The benefits of the large and high ceiling rooms are impression of spaciousness where reasonably uniform lighting levels are scattered throughout the room. The lightning is not the only reason for high ceiling rooms, pleasant visual proportions and high ceilings also allow to accommodate any general wall-mounted displays. In area control centers wall-mounted displays are essential because they usually contain charts and weather data, which is essential information for the work of and air traffic controller.

#### 2.3.1. Room layout

Room layout is also an aspect of the environment. The room needs to accommodate all the people that work in that working environment at the maximum capacity, including air traffic controllers, supervisors, on-the-job trainees, and the rest of the staff. Therefore, it needs to be spacious for smooth shift change between air traffic controllers, on-the-job training, and any on-the-job or controller assessments that might be underway without any distraction to the provision of air traffic control. There must be a back-up working position in the case something unexpectedly happens to the current working position and access to the safety equipment must be ensured at all times.

If the working environment is continuously staffed, the access to the room must be granted to the non-controller tasks such as regular maintenance, cleaning, visitors management, system checks, data gathering, upgrading the equipment and system, while the rest of the working environment is still operational. The idea is that the room layout is planned ahead and that all room activities and needs are planned in compliance with the working environment and tasks for that room, in order to avoid any impediments later on. However, if the room layout does not meet all the requirements, then the cost of upgrading and the later contentment is never the same as it was supposed to be initially. An example of room layout for area control center is shown in Figure 1.



*Figure 1: Example of room layout for area control center [3]*

### *2.3.2. Lighting*

In air traffic control there are two major working environments. One is in area centers where en-route and approach controllers operate and second is in aerodrome towers where aerodrome control operates. These are two significantly different working environments regarding the lighting. In aerodrome towers, ambient lighting varies drastically, from direct sunlight over the day and to an artificial lighting over the night. Since all the displays operate 24/7, it is important to adjust display brightness either manually or automatically, ensuring the controller is able to see the information on the display. Inadequate adjustments can cause the screen being too dimmed during the day and too bright during the night. Another solutions is to reduce ambient light during the day, but not so too prevent the controller to see the situation outside the tower.

The lighting in area control centers differs in a way that it is usually in enclosed room with no or just few windows, mostly covered, so no daylight can interfere with ambient lighting. In area centers ambient light is controlled and maintained all the time. Display brightness does not need to be adjusted frequently as in the tower since there are almost no variations in ambient lighting.

### *2.3.3. Colors*

In general, the unsaturated and pastel colors should be used on air traffic control (ATC) displays, while for important and temporary information the saturated colors are the sole choice. The latter should be used temporary because they can be visually disruptive. Some saturated colors, especially blue, can cause problems such as chromatic aberration and should not be used. To prevent confusion in air traffic controller work, chosen colors should be clearly distinguished from others and all should have clear names so there

cannot be a mistake when pronouncing one. The background information on the air traffic controller displays should be made discreet and with low color ratios. The brightness contrast ratio between dynamic information and the background information should be approximately 8:1 [4].

### 3. ERGONOMIC CHAIRS IN ATC

The air traffic controllers usually spend their working hours in a sitting position. Although sitting requires less physical effort than standing or walking, it puts a lot of stress on lumbar area. Combined effects of a sedentary lifestyle and a job that requires sitting can lead to various health problems. Other research showed that lumbar pain is the most influential on general comfort when sitting on a chair, followed by neck and dorsal pain [5]. All these medical issues lead to inefficient work, and when it comes to air traffic control, inefficient work may cause safety risk. That is the main reason why air traffic controllers use one of the most sophisticated ergonomic chairs. As stated earlier, a quality ergonomic chair should have a variety of customizable features, as it can be seen in Figure 2. Their console profile is well defined as to what should be a good practical distance and height when sitting on a chair in front of a working air traffic control console. In order to accommodate all body sizes of the controller population, the profile must meet all the ergonomic requirements, even by making some profile surfaces adjustable if necessary, see Figure 3.

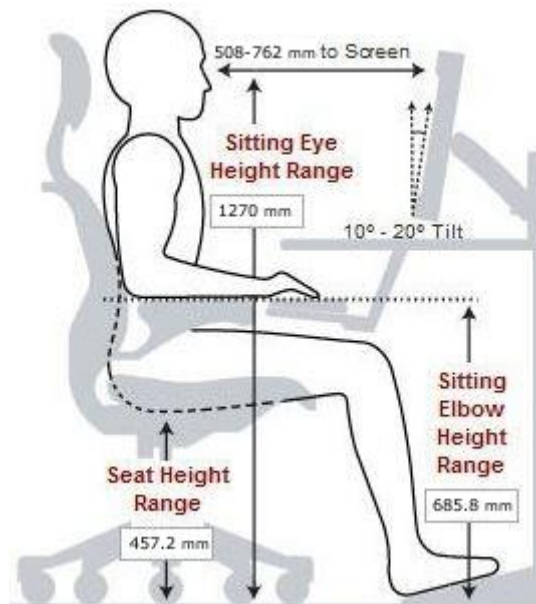


Figure 2: A preview of proper sitting posture in ergonomic chair [6]

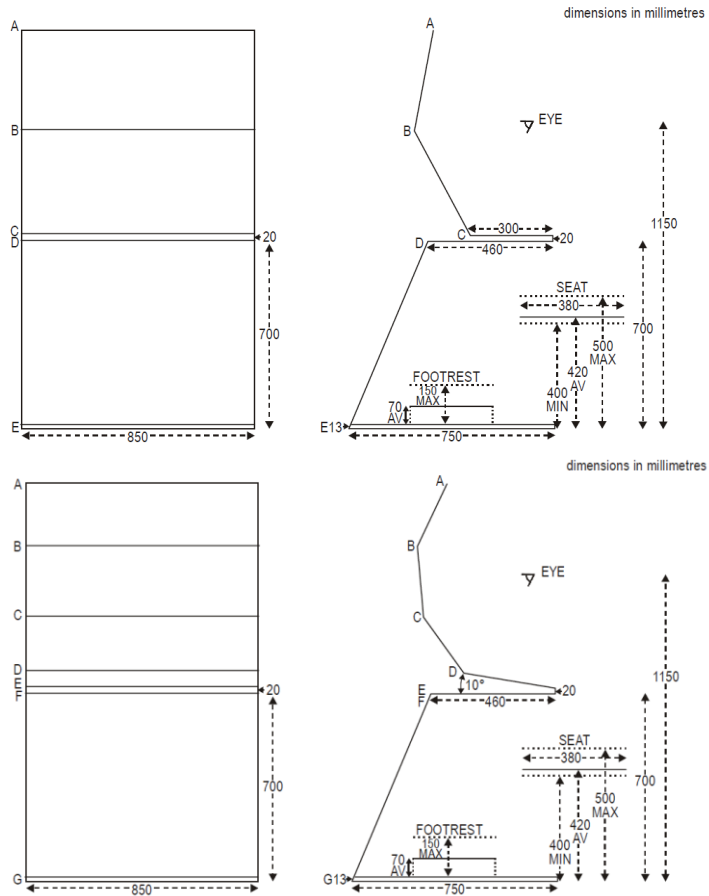


Figure 3: Side view of the outline formed by the set of surfaces presented to the controller seated at the work position and which contain the human machine interface. (Upper picture larger display, lower picture smaller display) [4]

### 3.1. Review of previous research

In this section a short review of a case study analysis done by authors W. Kleeman and T. Prunier [7] regarding evaluation of chairs used by air traffic controllers will be presented.

The chairs involved are task-intensive, meaning they are heavily used during three eight-hour shifts per day, seven days a week. 31.3% of the controllers spend sitting 4 hours or less during an eight-hour shift, 68.7% of them 5 to 8 hours per shift and 15% of them 7 to 8 hours per shift.

At the start of their shifts, 12.5% of them adjust their chairs, 41.2% find one that seems about right and 46.3% do neither, nor even do they adjust their chairs during the shift. Only 14.2% adjust their chairs during the shift.

The backrests are always used by 15.1% of controllers, 36.8% use them more than half the time, 30.4% use them about half the time, 17% use them less than half the time and only 0.7% never use them. Therefore, the controller's chair must have the backrest; a stool just would not do.

When enquired how they feel about their chair, 32.3% find their chairs unsatisfactory or barely satisfactory, 11.6% very satisfactory, 1.7% excellent and 54.4% find them satisfactory for a total of 67.7% favorable.

To question how do they feel while sitting in the chair, 4% are perfectly relaxed and 45.9% are very comfortable for a favorable total of 49.9%, while 39% are fairly uncomfortable, 8.5% are just plain uncomfortable, 1.9% feel acute discomfort and 0.7% feel pain for unfavorable majority of 50.1%; i. e. slightly more subjects are uncomfortable than comfortable.

There may be relationship between comfort and age. From age 15 through age 40, more people are uncomfortable than comfortable, 53.8% to 46.2%. From age 41 through age 65, more people are comfortable, 56.8% to 43.2%

Generally, the percentage of subjects who are comfortable declines as the length of time spent sitting increases. From 1 to 5 hours the percentages are on the comfortable side, 61.9% being comfortable at 1 hour; this declines to 50.5% being comfortable after 5 hours. At 6 hours the majority shifts to 51.4% uncomfortable and increases to 64.3% uncomfortable at 8 hours.

One more interesting thing to quote is that although the chairs are adjustable for back height, 53.1% of the subjects was not aware of it. This fact points up the requirement that complete user instructions of any adjustable chair must be given to the user and understood by the user.

Another case study analysis shows a theory of change model [8]. Where it shows the expectation that when an office ergonomics training program is implemented, an increase in ergonomics knowledge will motivate workers to modify working postures and behaviors (e.g., break patterns, workstation set-up). Thus ending with overall better sitting posture, satisfactory and in the end productivity. This relates to the previous paragraph where it shows that if not shown the instructions, controllers do not know how to properly operate with the chair.

## **4. CONCLUSION**

People undertake many different positions when they sit at work. Movement while seated is healthy but few people actually adjust their chairs. The ones who sit at their work rarely sit still. Previous studies of air traffic controllers ergonomics at the working environment have shown that bad sitting posture could cause several unwanted health issues. To avoid this, a good ergonomic chair is needed. But, as it was outlined in previous chapter, not all controllers feel comfortable with ergonomic chairs. Beside the ergonomic chairs, several

other ergonomic factors need to be satisfied to ensure good working environment ergonomics.

At the end, it can be concluded that not only ergonomic chairs are mandatory on workplaces of an air traffic control but it is advisable that all controllers go through ergonomics training program. As previous researches have shown [7, 8] if not given the proper education in ergonomics, employees can not use the given equipment in the best possible way. That, at the end, can result in health issues, decreased task performance and ultimately can cause safety issues.

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