Know your limits

by Maciej Szczukowski

Air traffic controllers' work is surrounded by definitions, theories and values. Safety, efficiency, delay, capacity, workload – these are every day notions in ATC.

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Some of them may be calculated and are ideally kept constant while others are variable and change throughout a shift. Most of the figures are a function of others and it is therefore more important to establish their limits rather than keep them at any particular level.

Workload is one of them.

For decades specialists have tried to find a formula to measure workload. Mathematical equations, quantitative and qualitative research or experiments as sophisticated as utilising functional spectroscopy to monitor the concentration of hemoglobin at the cortex[1] have been used. The most general formula science has come up with is "task" x "time" x "frequency". However, this ignores the complexity of ATC and workload remains a subjective concept, shifting among or trying to fit the statistics of task demands and the assumptions[2] about available technology. Consequently the most precise definition of ATCO workload we get today is the capacity of team's mind and body.

It is obvious that from a controller's point of view, each aircraft operation does not require the same amount of work. The concept of complexity is introduced to assess the level of difficulty perceived by controllers during traffic handling – based on the volume and nature of the required controller interventions. In parallel, ATC mental complexity describes the level of required mental response as determined by a controller's ability, knowledge and experience. It "reflects the relationship between the demands of a specific environment on the operator and the capability of the operator to meet those demands". The most well-known measure here is the "declared capacity". However, its limitation is that such a "declaration" is based only on ideal conditions and does not include any of the unpredictability which characterises most ATC environments. Adverse weather conditions which alter the traffic flow and restrict available airspace, equipment or communication problems and sudden and unplanned closures of taxiways or runways can both decrease capacity and significantly increase workload.

These are the times when managers and supervisors have to respond by reducing the demand. An example where the lack of such a reaction led to an overload for controllers occurred in Barcelona in December 2012. With low visibility procedures in force because of thick fog, only one runway was available for approaches. This led to a mean delay of around 40 minutes and approach control frequency was overburdened. "Break, break" was the most often-heard phraseology and very soon the approach controller was not able to coordinate relay the effects of delays or estimates. He was soon faced with many increasingly urgent crews' requests for approach clearances. Because aircraft were continuously being handed off from surrounding ACC sectors and supervisors did not support the controller in any way, the situation soon became even more urgent with crews beginning to report "fuel emergencies". This 'pushing tin' eventually reached its limit when the airport stated that there were no more parking spaces available. That is when one of the pilots was supposed to have said "let the aircraft land and put them on taxiway, car park, roof ... but on the ground!"[3].

To find the dynamic capacity of a sector, allowing to equate its effectiveness with actual demands and preferably to minimise the odds of a situation similar the one mentioned above, workload simulations are usually used. They calculate the sum of tasks required in different circumstances, although the relative simplicity of such calculations limits their versatility. One response to this is the idea of a peak traffic count based on practical experience. Such a threshold can be helpful in decision-making processes[4]. Another idea has been proposed by SESAR according to which, instead of regulating large volumes of traffic, the entry of complex, but local, airspace by too many aircraft in short periods of time should be prevented. The obvious problem, as in any approach, is that the prediction has to be made well in advance[5].

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In 1999, Heil presented an inductive model of enquiry based on knowledge of the relationship between air traffic controllers' ages and their performance. By referring to previous research[6] and by creating a series of tests for over 800 active controllers, he was able to confirm the theory that ATCO performance only increases until the mid 40s. The hypothesis was advanced that the relationship between age and performance is not necessarily linear and that although there is a negative correlation between age and performance on tasks requiring cognitive abilities, it is not so in case of tasks requiring experience and knowledge. Unfortunately the quantitative approach to the research missed participants' subjective feelings about their qualifications, environment and the influence of these on their ability to main-

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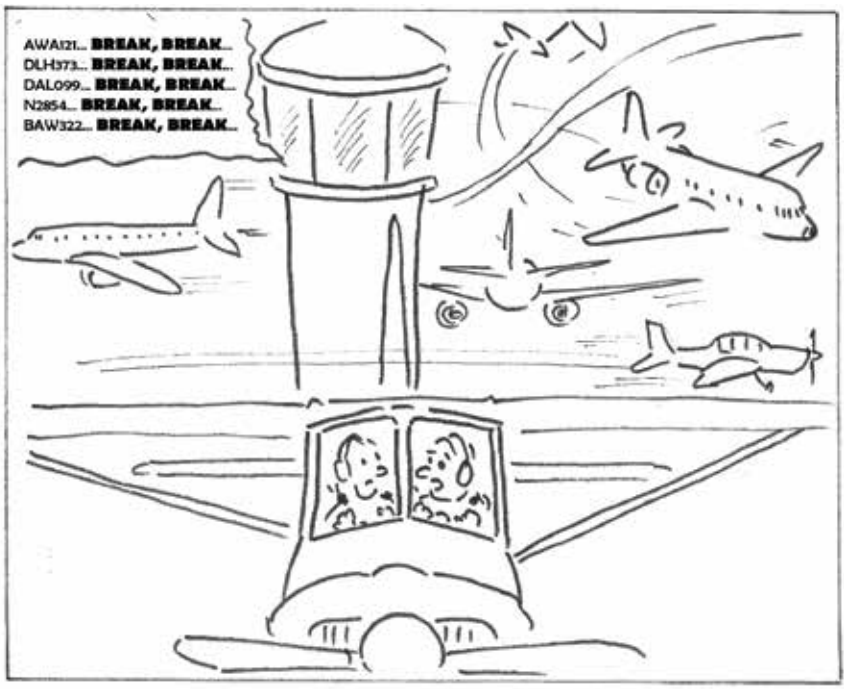
4 - Welch J.D., Andrews J.W., Martin B.D. (n.d.) Macroscopic Workload Model For Estimating En Route Sector Capacity.Retrieved from https://www.ll.mit.edu/mission/aviation/publications/publication-files/ms-papers/Welch_2007_ATM_MS-28122_WW-18698.pdf
5 - Suárez N., López P., Puntero E., Rodriguez S. Quantifying Air Traffic Controller Mental Workload. Fourth SESAR Innovation Days, 25th–27th November 2014. Retrieved from http://www.sesarinnovationdays.eu/sites/default/files/media/SIDs/SID%202014-03.pdf
6 - Salthouse (1991), Hardy & Parasuraman (1997), Tsang & Shaner (1998).

Know your limits (cont'd)



So you can hear it for yourself... They said that the controllers are overworked, but the only thing they do is to ask for BREAKS...

tain adequate competence with increasing age. And the researchers did not take into account the level of fatigue of controllers taking part either[7]. The reasonable conclusion from such work is that workload is actually not a function of the number of tasks but rather a consequence of the division of duties. Another challenge for senior controllers and supervisors in effective task allocations hence, for example, correct sector configuration[8].

The expression 'excessive workload' suggests that the acceptable upper limit of demand has been exceeded. However, a low workload level has its own problems. In July 2010, a Boeing 737 was cleared to cross a runway on which another aircraft had already been cleared for takeoff, though it was still taxiing to the departure runway. The safety net for the 737 crew – asking about a stop bar still turned on – did not work (the trainee controller switched it off). The investigation concluded that there had been ATCO overconfidence and inattention because of the "undemanding environment as seen by the workload at the time". In this case, division of duties as mentioned above was involved – On-the-Job Training was in progress during the occurrence[9].

But workload is not only about tasks and duties. It is also affected by personal variables like skills and experience in an encountered type and structure of traffic or one's proneness to apprehension. It expresses itself in ATCO behaviour and fatigue. The latter in turn includes drowsiness, decreased concentration and reaction time. Research conducted by Repetti showed that there is a relationship between daily workload (traffic volume and visibility at the airport) and a controller's behaviour after work (the degree of social withdrawal and the extent of expression of anger)[10]. On days of high workload and distressing interactions with co-workers or supervisors, ATCOs reported more health complaints and more negative moods[11]. It seems however that although social withdrawal „may help an aroused individual to return to a baseline emotional and physiological state", supportive spouses are also able to diminish the effects of workload related stressors.

There is no single standard which can anticipate all elements increasing workload[12]. New models are being created, including the EUROCONTROL Capacity Analyser tool (CAPAN), which uses RAMS (Reorganised ATC Mathematical Simulator) to "translate" quantitative values from simulated control positions into qualitative categories of traffic load[13]. We now need to focus more on mental workload models rather than dispassionate mathematical formulae. Creating dynamic thresholds, based on situational awareness, decision-making processes, matched with local procedures and demands but taking into account the psychological factors inherent in ATC profession, is the way to go. Otherwise, everything we will gain from controller effectiveness in a high demand environment, will be lost later due to the negative effects of overwork.

I believe that it is an obligation of each controller to establish their own workload limits, keep to such limits and communicate them to their team. It is essential to be open to changing them and to remain open for discussion about them throughout one's career. And after changes in equipment, procedures, airspace or airport structure, it is important to tell those who are responsible about any significant effects of changes, including how their decisions affect controller workload. If controllers' views are not heard, any feeling that one's own workload limit is approaching is actually the last moment to stop, let something go or accept the delay. There is only one little step between such a limit and no safety at all. Don't take that step.

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12 - Welch J.D., et al., op. cit.
13 - http://www.eurocontrol.int/sites/default/files/library/026_Pessimistic_Sector_Capacity.pdf