Fluency for Air Traffic Control
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1 Introduction The aviation community, led by the International Civil Aviation Organisation (ICAO) in Montreal, is to certificate the English language skills of all pilots, navigators, and air traffic controllers by March 2008. Testing (from which native speakers are not excluded, cf. Atherton, 2006) will be done by member organisations (e.g. FAA in the USA, the CAA in the UK) but will conform to standards and scales set by ICAO (2006a). The marking scale for language proficiency consists of six levels, with Level 3 (Pre-Operational) being non-passing, and Level 4 (Operational) being passing. The levels apply across six proficiency skills: Pronunciation, Comprehension, Fluency, Interaction, Structure and Vocabulary. This paper looks at Levels 3, 4, & 5 of the Fluency skill, and presents an analysis of the short-sample recordings published by ICAO to illustrate fluency at these three levels. ICAO acknowledges that fluency is 'a concept difficult to define' and adds that 'most speakers have an intuitive sense of what it is' (ICAO, 2006a: Appendix A12) This paper attempts to put numbers to the 'intuitive sense' of fluency, by providing a quantitative analysis of features of the sample recordings.

2 The Fluency Scale Table 1 shows the ICAO fluency scale, with Levels 1 and 2, and mention of 'discourse markers' omitted.

Level 6 – Expert	Level 5 - Extended	Level 4 – Operational	Level 3 – Pre-operational
Able to speak at length with a natural, <u>effortless flow</u>. <u>Varies speech flow for stylistic effect</u>, e.g. to emphasize a point. ...	Able to speak at length <u>with relative ease</u> on familiar topics, but <u>may not vary speech flow as a stylistic device</u>. ...	Produces stretches of language <u>at an appropriate tempo</u>. There may be occasional loss of fluency on transition from rehearsed or formulaic speech to spontaneous interaction, but this does not prevent effective communication. ...<u>Fillers are not distracting</u>.	Produces stretches of language, but phrasing and pausing are often inappropriate. <u>Hesitations or slowness in language processing may prevent effective communication</u>. <u>Fillers are sometimes distracting</u>.

Table 1. ICAO Fluency Levels.

Table 1 is the source of features that I attempt to quantify in the recordings. Columns 1 and 2 show that key concerns for Levels 6 and 5 include 'speech flow', which I interpret to mean a combination of continuity (=keeping going) and the ability to be non-predictably variable (= interesting) while speaking. The issue of speed comes into the description of Level 4 (passing level) with 'at an appropriate tempo' and Level 3 'hesitations or slowness in language processing' will mean you don't pass. There is also a 'fillers' parameter - distracting fillers will get you a Level 3 (non-passing) grade, and fillers which are not distracting will get you a passing Level 4 grade. So in what follows, I will focus on varying speech flow, target speed, pausing, and fillers, to see if there are quantifiable differences (as opposed to merely intuitively sensed differences) between the levels.

3 Recordings Table 2 summarises the extent – both in minutes/seconds and

speech units – of the short sample recordings, and the number of voices on the recordings.

Recording	Duration	Voices	Speech units
Level 3	2:28	3 (2)	83
Level 4	2:34	4 (4)	126
Level 5	0:36	2 (1)	29

Table 2. Short sample recordings.

The analysis covered a total of just over five and a half minutes of the ICAO short samples. The first voice of Fluency Level 4 was not used in the analysis, because of poor quality of the recording. This is not a large sample, nor is it a balanced one (the Level 5 recording is very short) so results and conclusions must therefore be treated with caution.

The third column of the table shows (a) the number of voices heard on the recordings, (test-taker voices) on the left; and (b) the figures in parentheses are those for the interviewers, whose contributions were excluded from the analysis. The last column gives the number of speech units uttered by the test takers in each recording.

4 Speech Units A speech unit is a stretch of the stream of speech that has a rhythm which sets it apart from surrounding speech units, contains one tone, and may contain up to four prominent syllables, but usually one or two prominences. It derives from the research of Brazil (1985). This approach has been used for research into ELT learner speech (Hewings, 1998) and it is used as the mode of presentation of spontaneous speech in SpeechInAction publications (e.g. Cauldwell, 2002, 2007). It is ideal for the analysis of spontaneous speech, because it respects the existence of performance phenomena, such as pausing, rhythmic changes, the location of stresses (prominences) and tones. It is unhooked from expectations of what 'ought to happen' and is hooked to what 'actually happens' when speakers compose their speech in real time. This is an example of a speech unit analysis from Fluency Level 5:

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01 // and there was a //                    310
02 // this particular passenger //          150
03 // had um //                             120
04 // an existing medical condition //      100
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Each line is a speech unit: the numbers on the left are reference numbers for each unit; the double slash (//) marks the speech unit boundaries; and the numbers down the right hand side indicate the speed in words per minute. In the above extract, notice that the clause is spread over four units: 01 seems start a structure that goes 'there was a passenger who' which is discarded; the subject of the clause is in 02; 03 contains a filled pause 'um', and the object of the 'had' is in a separate speech unit, 04. All these features are typical of expert-speaker spontaneous speech.

5 Average Speed Table 3 shows the speed of, and the numbers of words and syllables in speech units.

	Level 3	Level 4	Level 5
Words per minute	100	130	180
Words per speech unit	1.8	2.1	2.8
Syllables per speech unit	2.4	2.8	4.3

Table 3. Average speeds.

Table 3 shows that the average speed of speech, measured in words per minute (wpm), increases from level to level. Level 3 (non-passing) has an average of 100 wpm, Level 4 (passing) has an average speed of 130 wpm, and the Extended Level has an average of 180 wpm. The fourth and fifth rows show increases in average numbers of words, and syllables, per speech unit as we proceed from Level 3 to Level 5: the higher the level, the more words, the more syllables per speech unit. On this evidence, there is a correlation between speed and Level - the faster the average speed of a speech unit the higher the level you will get; second, there is a correlation between the length of speech units, and level - the more proficient someone is, the longer their speech units (=rhythmic stretches of the stream of speech) will be.

6 Speech Flow We now look at the extent to which speech flow varies, by looking at the distribution of slow, medium and fast speech units, which are displayed in Table 5.

Band	Speed/wpm	Level 3	Level 4	Level 5
slow	000-100	57	38	17
medium	101-200	39	52	51
fast	200-350	4	10	31

Table 4. Percentages of Slow, Medium, and Fast speech units.

The left hand column shows three speed bands: 'Slow' - up to 100 wpm; 'Medium' - between 100 and 200 wpm; and 'Fast' - between 200 and 350 wpm. Reading across, you can see that the Level 3 sample has 57% of speech units in the slow band, whereas Levels 4 & 5 have 38% and 17% respectively – thus, on this evidence, the higher the level of proficiency, the fewer slow speech units there are. In the Medium band, the picture is slightly less clear: level 3 has 39% speech units at Medium, whereas levels 4 and 5 have very similar percentages at around 50%. Nevertheless, at the pass-boundary, between Levels 3, and 4 there is a marked jump in percentage. In the Fast band (200-350) the higher the level, the higher the percentage of speech units – with Level 3 having only 4% fast speech units, Level 4 having 10%, and Level 5 having 31% speech units in this higher speed bracket. On this evidence, someone who wants to progress from non-passing Level 3 to passing Level 4 should work on increasing their ability to speak medium speed (100-200 wpm) and fast speech units (200-350 wpm). For examples of German, American, British, and French aviation professionals working at Level 5 and above (in routine Air Traffic Control), see Cauldwell (2007).

7 Silent Pauses Silent pauses were removed from consideration to compute average speeds of speech units discussed above. But it is an important parameter, to which we now turn.

	Level 3	Level 4	Level 5
Duration of takers' speech (seconds)	144	146	32
Total duration of silent pauses (seconds)	47	20	3
Percentage	33%	14%	9%

Table 5. Pausing

Table 5 reveals that there are clear differences, by level, in the occurrence of silent pauses. Level 3 (non-passing) performances are characterised by having 33% silent pauses; Level 4 (passing) performances have 14%, and Level 5, 9% silent pauses. It would seem that there is a clear correlation between the amount of silent pausing and performance level. One striking example occurs in the short sample for Fluency level 3. The interviewer asks 'How is aviation regulated?' There is then an eleven second silent pause, and the test-taker says 'I understood' – silently pauses for a further four seconds and then begins his reply. The answer, when it comes, is satisfactory, but those long pauses have scuppered the candidate's chances of being assessed at Level 4. On this evidence the imperative would seem to be 'keep going', and one of the ways of keeping going is to use filled pauses, and fillers of other kinds, to which we now turn our attention

8 Ums and Uhs Table 6 shows the percentages of speech units which either consist only of 'uh' or 'um', or of 'uh' or 'um' plus other words, as illustrated by these units from Level 3:

01 // uh // 050
02 // uh some food // 120

	Level 3	*Level 4*	*Level 5*
Units with uh/um only	17%	15%	0%
Units with uh/um plus ...	16%	16%	3%

Table 6. Percentages of speech units with um and uh

Table 6 shows that, the occurrence of 'um's and 'uh's is not a critical factor in distinguishing Level 3 (non-passing) from Level 4 (passing). Indeed, they are very close in percentage terms, with 17% of Level 3 speech units consisting solely of either 'um' or 'uh' and Level 4 having 15%. The two levels have identical percentages for speech units which contain other words as well as 'uh' or 'um'. On this evidence, the use of filled pauses would seem a much safer strategy than silent pauses.

9 Concluding remarks This paper attempts to quantify the 'intuitive' phenomenon of fluency. The ICAO scales identify parameters on which test-takers will be judged (e.g. speech flow); the recordings give authoritative evidence for what counts as fluency at Levels 3, 4, & 5. For language educators and testers, the critical decisions lie on the passing and non-passing Levels (3 & 4). On the evidence of the recordings, to progress from Level 3 to Level 4, you need to: increase the average speed of your speech by 30% (from 100 to 130 wpm); make your speech units longer (words and syllables), increase the percentages of medium and fast speech units by 20%; reduce silent pauses to 15% of duration; use filled pauses.

10 References
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