

# Defining Fluency for Air Traffic Control.

## 1. Introduction

These days, more people are travelling by plane, more airline routes are opening up, and more airlines are flying internationally. As a result, increasing numbers of pilots, air-traffic controllers and navigators are engaged the communications designed to ensure safe Air Traffic Control worldwide. And the language in which they do it is English, even in locations where it is not the 'home' language of either the plane or the ground, English is used. You might think that all the people involved have English language qualifications according to internationally agreed standards. Not so, not yet. But by March 5<sup>th</sup> 2008 all will have to have been examined, and to have demonstrated that their pronunciation and listening skills are sufficiently high for them to be deemed 'safe' for air-traffic communications, whether routine or non-routine. In the jargon of the standards set by the International Civil Aviation Organisation [ICAO], they will have to achieve at least 'Operational Level 4'. 'Operational Level 4' is a reference to the Language Proficiency Rating Scale (LPR Scale), which consists of six skill areas, and six proficiency levels, which will be described in the next section.

This paper is a study of just one of the Proficiency skills identified by ICAO – Fluency. In particular, it is a study of the recordings which illustrate different levels of Fluency. Two reasons led me to focus on this skill. First, ICAO says of fluency that it is 'a concept difficult to define but most speakers have an intuitive sense of what it is' (ICAO, 2006a, Appendix A12) and I believe that recent techniques in analysis of spontaneous speech (e.g. Cauldwell, 2004) could help quantify 'the intuitive sense' particularly in terms of speech flow, tempo, and fillers. Second, a recommendation to 'maintain an even rate of speech not exceeding 100 words per minute' (ICAO, 2006b, 2-1) caught my eye. In my experience, this is an uncomfortable, unrealistically slow speed of speech to recommend. So I was keen to do two things: quantify the differences in fluency factors (speed, etc) at the different skill levels, and to see whether the 100 words per minute recommendation is in any way justified.

In what follows, I shall:

- (a) briefly describe the ICAO's six-skill Language Proficiency Scale;
- (b) highlight issues appertaining to the Fluency scale;
- (c) describe the recordings and the method of analysis;
- (d) report findings relating to average speed, variation in speech flow, pausing, and fillers;
- (e) discuss the significance of the findings, and make recommendations for teaching activities.

## 2. The ICAO Language Proficiency Rating Scale

ICAO's Language Proficiency Rating Scale is published to ensure a consistent standard against which test takers worldwide will be graded. The LPR scale is published on CD-ROM (ICAO, 2006a) and consists of both a written scale, and recordings illustrating different levels of proficiency. The skills are: Pronunciation, Structure, Vocabulary, Fluency, Comprehension, and Interactions; the six levels go from Pre Elementary Level 1 up to Expert Level 6. There is not space here to display the full scales. You can find them by Googling ICAO LPR. (International Civil Aviation Organisation Language Proficiency Requirements). The critical boundary test-takers is between Level 4 – Operational level, which is the passing level, and Level 3 – Pre-operational level, which is a non-passing level.

## 3. The Fluency Scale

Table 1 shows the ICAO fluency scale, with Levels 1 and 2 omitted, for reasons of space.

<i>Level 6 – Expert</i>	<i>Level 5 - Extended</i>	<i>Level 4 – Operational – Passing level</i>	<i>Level 3 – Pre-operational</i>
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. Uses appropriate discourse markers and connectors spontaneously.	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> . Can make use of appropriate discourse markers or connectors.	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. Can make limited use of discourse markers or connectors. <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 Language Proficiency Fluency scale

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 target speech flow, speed, pausing, and fillers, to see if there are quantifiable differences (as opposed to merely intuitively sensed differences) between the levels.

## 4. Recordings

The ICAO scales are supplemented with recordings of two types: thirteen extended samples of between five and twenty minutes in length which focus on single individuals; and seventeen short samples – each comprising a number of different voices. These short samples illustrate the performance levels expected in proficiency skill. No short samples are given of Levels 6 or 2, the main focus is on Level 4 and 3 (six samples each) and Level 5 (five samples).

The recordings used in the following analysis are of the short sample recordings for Levels 5, 4, and 3 of the Fluency scale, but the first voice of Fluency Level 4 was not used in the analysis, because of poor quality of the recording. The short samples consist of interviews with individuals who speak about their jobs, situations they have faced while working, and issues faced by the air industry. In addition to the ICAO short samples, I performed a comparable analysis of some live ATC between an apron controller (he directs departing aircraft from their gates, via taxi-ways, to runways) and four pilots (British, German, French, and American) at Frankfurt Airport. Table 2 summarises the duration and number of voices heard on each of the recordings.

<i>Recording</i>	<i>Duration</i>	<i>Voices</i>	<i>Speech units</i>	<i>Taker units</i>
Fluency Level 3	2:28	3 (2)	110	83
Fluency Level 4	2:34	4 (4)	156	126
Fluency Level 5	0:36	2 (1)	36	29
Frankfurt ATC	2:04	5	108	108

Table 2. Details of the ICAO Fluency short samples

A total of seven minutes forty-two seconds was analysed, of which just over five and a half minutes was of the ICAO short samples. Five and a half minutes of recordings is not a large sample, so results and conclusions must therefore be treated cautiously. However, the short sample recordings constitute a public (therefore 'authoritative') statement of ICAO's view that the performances of the test-takers are at the respective Levels. The third column of the table show the number of voices heard on the recordings, the figures on the left indicate the number of test-takers, the figures in parentheses are those for the interviewers, whose contributions were excluded from the analysis. For the Frankfurt ATC, there were a total of five voices, one controller and four pilots. The last column in Table 3 gives the number of speech units in each recording. The speech unit is the unit of analysis in this study. The next section

explains, briefly, the concept of the speech unit.

## 5. *Speech units Method of Analysis*

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 only, and may contain up to four prominent syllables, but usually has only one or two prominences. It is a unit of analysis derived from Discourse Intonation (Brazil, 1985). Discourse Intonation (DI) 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 (Cauldwell, 2002, 2005a, 2005b, 2006). DI is well suited to the analysis of spontaneous speech because it respects the importance 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' according to the grammar, and is hooked to what 'actually happens' when speakers compose their speech in real time.

This is an example of a speech unit analysis of the short sample recording illustrating Fluency Level 5

01	// and there was a //	310
02	// this particular passenger //	150
03	// had um //	120
04	// an existing medical condition //	100

Each line is a speech unit: the numbers on the left are reference numbers, for each unit, the double slash (//) marks the boundaries of the speech unit, and the numbers down the right hand side indicate the speed in words per minute. Notice that the clause is spread over four units: 01 seems to start a structure that goes 'there was a passenger who' which is discarded; the new subject of the clause is in 02; 03 contains a filled pause 'um', and the object of the verb 'had' is in a separate speech unit, 04. All these features are typical of spontaneous speech.

If we now look at the routine communications between Pilot and Air Traffic Control (ATC), we can see that the communications are more orderly.

Pilot:		
01	// air france one four zero three //	150
02	// is ready to taxi //	210
Control:		
03	// air france one four zero three //	250
04	// taxi to runway one eight //	270
05	// via taxiway november //	180

(Cauldwell, 2007)

In this extract there is a much tidier relationship between speech units and their contents ... and this is typical of routine, formulaic, repetitious nature of these communications which are governed by an internationally agreed manuals (ICAO, 2006b).

## 6. *Analysis*

### 6.1 *Average Speed*

Table 3 shows the findings for speed and size of the speech units of the ICAO Short Samples. In order to compute the speed of speech of the test takers, I discounted those speech units that belonged to the interviewers. I also removed pauses of 0.2 seconds or longer from the computation.

	<i>ICAO Short Samples</i>		
<i>Averages</i>	<i>Level 3</i>	<i>Level 4</i>	<i>Level 5</i>
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. Speed, words, and syllables in speech units of ICAO short samples

Table 3 shows that the average speed of speech, measured in words per minute, increases from level to level. Level 3 (non-passing) has an average of 100 words per minute, Level 4 (passing) has an average speed of 130 words per minute, and the Extended Level has an average of 180 words per minute. 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.

It is worth checking, at this point, how these measures relate to real Air Traffic Control. Table 4 compares the evidence of Table 3 to Frankfurt ATC.

	<i>ICAO Short Samples</i>			<i>Frankfurt ATC</i>		
<i>Averages</i>	<i>Level 3</i>	<i>Level 4</i>	<i>Level 5</i>	<i>Pilots</i>	<i>Control</i>	<i>Both</i>
Words per minute	100	130	180	150	190	170
Words per speech unit	1.8	2.1	2.8	2.6	3.6	3
Syllables per speech unit	2.4	2.8	4.3	3.8	5.5	4.5

Table 4. Speed, words, and syllables in speech units of ICAO short samples and ATC

The three columns on the right show the figures for speed, words, and syllables of the speech units of the Frankfurt ATC recording. The 'Pilots' column shows the figure for the four pilots who communicate from the flightdecks of their planes, the 'Control' column shows the figures for the one controller, and the 'Both' column shows the figures for controller and pilots together. It is interesting that the controller speaks faster (190 wpm), and his speech units contain more words and syllables, than those of the pilots (150 wpm). This is possibly because the controller is giving very similar instructions all day, repeatedly using a small number of terms relating to the layout peculiar to Frankfurt airport ('taxiway november') – whereas the pilots have a far wider range of communications to perform.

Comparison of the figures for ATC and short samples shows that the controller and pilots are operating at fluency levels around Level 5: the average speed for controller and pilots together is 170, far closer to Level 5's 180 than to Level 4's 130. It is important to acknowledge the fact that we are not comparing like with like, because the ATC recording consists of formulaic utterances in conformity with a published manual (ICAO 2006b), and the short sample recordings are of spontaneous speech on a variety of topics. Nevertheless, it is interesting that the live ATC communications measure up to Level 5, and go above the 100 wpm recommended in ICAO's Radio Telephony Manual (ICAO, 2006b, p. 2-1)

## 6.2 Varying speed

The fluency descriptions for Levels 6 and 5 mention the ability to 'vary speech flow'. In the preceding section we dealt with averages. 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.

		<i>ICAO Short Samples</i>			<i>Frankfurt ATC</i>		
<b>Band</b>	<b>Speed/wpm</b>	<b>Level 3</b>	<b>Level 4</b>	<b>Level 5</b>	<b>Pilots</b>	<b>Control</b>	<b>Both</b>
slow	000-100	57	38	17	30	12	22
medium	101-200	39	52	51	48	53	50
fast	200-350	4	10	31	22	35	28
		n = 83	n = 126	n = 29	n = 64	n = 44	n = 108

Table 5. Speech units at slow medium and fast speeds.

The left hand column shows three speed bands: 'Slow' - up to 100 words per minute; '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 lower the proportion of slow speech units.

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 Pre-Operational level 3 to Operational level 4 would do well to work on increasing their ability to speak medium speed speech units (100-200 wpm) and fast speech units (200-350 wpm). However, it would be a mistake to think that the higher your Level, the ever higher your percentage of fast speech units should go. It is important that there is a balance of speech units at different speeds.

## 6.3 Pausing

The preceding analysis has not taken silent pauses into account, as these were removed to compute average speeds of speech units. However, examination of the extent of silent pausing is instructive.

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

Table 6. Silent pauses

Table 6 reveals that there are clear differences, by level, in the occurrence of silent pauses. A Level 3 (non-passing) performance is characterised by having 33% of the duration of the recording in silent pauses; a Level 4 (passing) performance has 14%, and Level 5, 9%. 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 aviation is regulated by ICAO...'. The answer, when it comes, seems 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.

## 6.4 Fillers - Ums and Uhs

Table 7 shows the percentages of speech units which consist only of 'uh' or 'um', and also the percentage of speech units which contain other words, but also have 'uh' or 'um' in them. Two speech units from Level 3 exemplify the two types of occurrence:

Level 3  
01 // uh // 050  
02 // uh some food // 120

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

Table 7 Speech units with 'uh' and 'um'

Table 7 shows, that on the evidence of the short-sample recordings, 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'.

There is however, a big drop in percentage of 'uh/um's in the Level 5 recordings. But this short sample recording was so much shorter than the others (one quarter), that one cannot attribute any significance to this figure.

## 7.0 Discussion – Objectives and Activities

### 7.1 Objectives – Keep Going

From the evidence reported in the preceding sections, we can derive the following objectives for someone assessed at Level 3 and who wants to improve to Level 4:

- Raise the average speed of speech by 30% (from 100 wpm to 130 wpm)
- Raise the number of words in speech units by 17% (from 1.8 to 2.1)
- Raise the number of syllables in speech units by 17% (from 2.4 to 2.8)
- Raise the percentage of speech units at medium/fast speeds by 19% (from 43% to 62%).
- Reduce silent pauses by 19% (from 33% to 14%).
- Continue to use the same proportions of 'um' and 'uh'.

In my view, all of these individual objectives can be subsumed under the single instruction: 'Keep going!' Thus, we need to develop a set of practise exercises, including drills, to promote this 'keeping going'.

### 7.2 Activities

I suggest that in addition to doing pronunciation work on discrete sounds, students should practise pronunciation of words that occur together in rhythmic bursts (speech units). Choose short recordings of spontaneous speech, break them up into speech units and use the speech units as a pronunciation model. Take the following example which shows a speaker starting, then changing his mind about how to structure what he wants to say:

```

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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Get students to listen, imitate, record, and compare their own performances to the original recording. Get them to imitate the changes in speed, the changes of mind that speakers make (e.g. between 01 and 02), the fillers ('um' in 03). This will develop in them a sense of what it is like to operate with the stream of speech, to start boldly (no silent pauses), and then change their minds while preserving continuity.

The next extract shows a speaker keeping going by using level tones on the underlined syllables:

```

01 // this is // 090
02 // a manual // 050
03 // for // 090
04 // both // 120
05 // reading // 130
06 // and writing // 140 (Cauldwell, 2002, Chapter 5)

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The level tones on 'is', 'for', 'both' and 'read' elongate the syllables, and buy the speaker time to decide what to say next – again he is keeping going, not producing silent pauses. Being able to produce a level tone, elongating a syllable at will, is an important skill, easy to learn and teach.

Another way of keeping going is by using repetitions, as in the following extract, in which a speaker describes salsa dancing – the repetitions are underlined:

```

01 // the two dancers can be very independent but // 240
02 // but still um // 180
03 // still it's very // 145
04 // it's very led and be led // 210 (Cauldwell, forthcoming)

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Note how the repetitions bind the speech units together, adding elements of continuity to the ongoing discourse, but allowing the speaker to buy time to decide what to say, while minimising the use of silent pauses.

When looked at on paper, these extracts from spontaneous speech look messy, and may offend your sense of how English ought to be spoken. Competent professionals, you might feel, ought to be able to speak eloquently, to know what they are going to say, say it with precision, without repetition, and in an interesting way. Well, most fluent spontaneous speech (especially from native-speakers) is not like that. It is important, in my view, to move away from notions of how English 'ought to be', to use everyday spontaneous speech as a source of evidence for strategies on how to keep going. It is important to value the apparently messy (restarts, repetitions, etc) and to consider the possibility that they are expert-speaker strategies which help speakers participate in the rough and tumble of everyday speech.

## 8. Conclusion

In this paper I have reported the results of analysis of recordings of short samples of non-passing performances (Level 3) and passing performances (Levels 4 & 5) on the ICAO Fluency scale. These recordings are 'authoritative' in the sense that ICAO has put its name to them, and assessed them at the respective levels. Private communications I have had with ATC educators in Europe have reveal dissatisfaction with these recordings – the thinking is that the Level 4 recordings indicate too low a level of performance. This paper reveals that the Frankfurt ATC recording is operating more at Level 5 (Extended) fluency, rather than Level 4. So if the Frankfurt voices represent the target competence for European educators, then they are setting their targets higher than those required by ICAO. However, it is important to be cautious about the evidence reported above because the amount of data analysed is

very small, and further analysis of other recordings might lead to different results. In particular, the Level 5 short sample is very short, at 36 seconds, about one quarter the length of the other recordings.

As the testing process matures over the years, and as research into the testing process and examinee and examiner performance develops, more recorded evidence will become available for analysis, which will enable further important parameters to be identified and worked on. I have also made some recommendations for fluency practice which follow on from the findings of the differences between Level 3 and Level 4. These of course relate only to the Fluency scale, and would need to sit alongside additional work that aims at improving Vocabulary, Structure, Comprehension, Interactions, and Pronunciation.

Lastly, it would seem that the ATC field as a whole (administrators, examiners, trainees, operatives) need to develop a more accurate sense of the speed of speech, based on the evidence of both Air Traffic Control interactions (such as the Frankfurt recordings) and on the evidence of recordings of spontaneous speech. The 100 wpm recommendation (ICAO, 2006b) still seems to me to be unrealistically, and impractically slow for inter-native speaker, and inter-European communications, where people are used to each others' accents. However it may be an appropriate speed to speak at when a new, or unfamiliar accent is encountered – and for this to happen, training in the skill of speaking at different speeds would seem to be a pre-requisite.

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