Central Modals in an Aviation Corpus: Frequency and Distribution*

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1 Introduction

This paper will examine the frequency and distribution of central modals (*can, could, may, might, must, shall, should, will, would*) in aviation manuals, using a corpus-based, and predominantly quantitative, approach. For that purpose, a corpus consisting of three manuals for the BOEING 737 was compiled. The study will also explore the extent to which a mostly automated quantitative analysis of an unannotated corpus[1] can yield helpful insights into the frequency and distribution of central modals in aviation manuals, and comment on the utility of combining quantitative and qualitative approaches. The examination will involve comparisons of frequencies of central modals, both as a group and individually, between the AC and a representative corpus of American English (FROWN[2]), as well as between the three manuals comprising the AC.

* This paper is partly based on Sarmento (2005).

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[1] Annotation was used in two instances. First, when establishing the frequency of central modals in FROWN, in order to avoid taking into account *May* (the month), as well as *can, might, must* and *will* used as nouns. Second, manual annotation was carried out in order to establish the modality type expressed by central modals in AC.

[2] Abbreviations can be found in Appendix 2.

The development of terminology (i.e. a specialized lexicon) dates as far back as specialized knowledge. Professionals in any given area have always been concerned with the specific vocabulary of their field of knowledge. However, the study of the lexical component in specialized communication is a relatively recent phenomenon, having started in the second half of the 20th century (Krieger & Finatto, 2004). The reasons for the growing importance of the area are manifold. First, the continuing development of science and technology requires new terms for new discoveries and inventions. More recently, globalization fostered a whole range of intercultural, inter-technological, and inter-scientific encounters. This interaction has increased the need of professionals using technical/scientific terminology, such as translators, interpreters, technical writers, lexicographers and terminographers, for standardisation in specialised languages

Eugene Wuster (1998),[3] from the Vienna School of Terminology, created the General Theory of Terminology (GTT) (Krieger, 2001:49). The GTT, based on a positivist conception of science, aimed at coining and standardizing specialized terms worldwide. For the GTT, terms are not simply words, but units of knowledge. For example, Wuster (ibid.: 21) makes a distinction between the linguists' and the terminologists' points of view:

> To start with, all terminological work starts with "concepts" aiming at establishing clear delimitations. Terminology considers the concepts as independent from their denominations (the terms). Thus, terminologists refer to "concepts", whereas linguists refer to "word contents", or words in general language. For the terminologists, a terminological unit consists of a "word" with a separate concept as its meaning, whereas for most current linguists, a word is an inseparable unit composed of form and content.

According to their point of view, terms are not considered to be part of natural languages, but are seen as forming an artificial

[3] According to Krieger (2001), *General Introduction to Terminology and Terminological Lexicography* is a posthumous publication which collects Wusters' ideas presented in his classes at the University of Vienna in the seventies. It was published in Germany in 1979, just after his death, by his follower, Helmut Felber. This reference is to a Catalan translation recently published by the Applied Linguistic Institute from the University of Pompeu Fabra in Barcelona.

and controlled type of language, free from ambiguity and fuzziness. In this way, terms (and the specialised concepts they express) were not to be studied by linguists, but by professionals of a given area. In addition to the GTT's standardizing role, Wuster helped to establish Terminology as a field of knowledge, with an epistemological basis and its own object of study: the term. Nevertheless, the authors argue that the underlying theory of the GTT is limited, as far as description of specialized languages is concerned (Krieger & Finnato, 2004).

Cabré et al. (1998) were the pioneers in opposing the ideas of the Vienna School. Their main criticism is concerned with the idealized world conceived by the GTT, in which concepts, which are treated as pre-existing in relation to natural languages, are created in the laboratory, and labelled prescriptively. The underlying assumption in GTT is that all concepts are universal, regardless of differences in geographical, socio-economic, cultural, and linguistic contexts. From the criticisms of Cabré et al. (1988) stemmed the Communicative Theory of Terminology (CTT), which aims to cater for the complexity of specialized languages, adopting social, linguistic, and cognitive perspectives. For Cabré et al. (ibid.:38), specialized languages are not different from natural languages, being subject to the same linguistic rules. A specialized language is a natural language used by a community of specialists in a particular field of knowledge. Krieger (2001) argues that many general language lexical units undergo a terminologization process, that is, they acquire specialized meanings in specialized contexts. These specialized meanings co-occur with non specialized meanings when the units are found in more general contexts. Lexical units acquire the status of terms only when they are embedded in a certain technical or scientific area. According to the CTT, specialized languages are to be studied by linguists, and, whenever necessary, with the help of specialists in a given field.

The specialized language used in aviation technical manuals, which is the focus of the present study, has its own characteristics. To start with, English is considered the official language, and therefore, different aviation professionals worldwide have to use English for different purposes at different levels. One of these purposes is reading aviation technical manuals.

Pilots, mechanics and technicians have to understand every detail in the texts. A general understanding of the texts will not suffice, because even minor misunderstandings can cause serious damage, as has already been the case in several air accidents and incidents, in which communication failure has proven to be a causal or contributory factor (ICAO, 2004). For these reasons, a lot of effort is put into standardizing aviation language. The European airlines and airplane manufacturers created Simplified English (SE) with an aim to facilitate the work of writers (technical editors) and users (technicians, mechanics and pilots) of operation and maintenance manuals (Shawcross, 1993). Although not made explicit in the literature, SE seems to follow the principles established by the General Theory of Terminology (GTT).

At this point, we must call attention to an interesting discrepancy. Although a lot of effort has been expended on standardising aviation English on a prescriptive level, there is a dearth of empirical, descriptive studies which will help establish whether, and to what extent, standardisation guidelines are followed in practice. Krieger (2001) points out that most studies about specialized languages still have a narrow focus on the strict treatment of terms.[4] However, it has been maintained that other word classes (e.g. adjectives and verbs), as well as other types of multi-word units and phraseologies should also constitute objects of exploratory studies of specialised languages. Bevilacqua (1998), who is among the few scholars who look beyond terms in the strict sense, gives an account of specialized phraseology and its application in dictionaries, glossaries, etc. Sarmento (2004) analyzes how words borrowed from English function in aviation Portuguese, and examines the existing criteria for the inclusion of these borrowed words in aviation glossaries. Maciel (2001) describes the use of performative verbs in laws, and, more specifically, in the Brazilian constitution of 1988. Finatto et al. (2002; quoted in Krieger and Finatto, 2004) carried out an exploratory study of two modal verbs, *poder* (can, may) and *dever*

[4] GTT typically takes only nouns, noun-noun compounds and noun phrases as terms. Multi-word units constitute around 80% of the terms in all areas of knowledge (Krieger, 2001:30).

(must), in academic chemistry manuals written in Brazilian Portuguese. The authors cited above believe that a better understanding of how these verbs occur in different texts can contribute to the description of authorial styles or genres, as well as the field of knowledge.

Although not directly linked to the study of terminology, but still situated within the description of specialized languages, there have been a number of corpus-based studies on lexical aspects of academic and scientific discourse. For example, Coxhead (2002) used a corpus of academic writing to compile a word list for the teaching of academic English, Hyland (2002) analysed the use of directives in academic writing, and Gledhill (2000) and Luzon Marco (2000) focused on frequent collocations in pharmaceutical and medical research articles respectively. Because of the frequent use of hedging in academic/scientific writing, modality (in particular, epistemic modality) has been the focus of a number of studies. For example, Hegedus (2005) studied epistemic modality in drug information leaflets, and Thompson (2002) examined the use of modal verbs in academic writing. Other studies have compared the use of modality in the academic/scientific writing of native and non-native speakers, with a view to informing the teaching of academic/scientific writing (e.g. Gabrielatos & McEnery, 2005; Hyland & Milton, 1997; McEnery & Kiefle, 2002).

Comparative studies of the latter type can be adapted to the domain of manuals. The analysis of linguistic features of comparable manuals written by different authors, or produced by different companies, can reveal to what extent guidelines pertaining to a given specialised language are followed. In turn, the findings of such studies can inform the training of manual authors. This study aims to contribute to the analysis and description of the language actually used in aviation manuals, and, indirectly, to the standardisation of aviation English.

2 Modality and modals in English

Modality is related to the speaker's "opinion or attitude towards the proposition that the sentence expresses or the situation

that the proposition describes" (Lyons: 1977, 452), or, more specifically, it is "concerned with the speaker's attitude towards the factuality or actualisation of the situation expressed by the rest of the clause" (Huddleston & Pullum, 2002: 173). Palmer (1986: 16) argues that modality "is concerned with subjective characteristics of an utterance, and it could even be further argued that subjectivity is an essential criterion for modality".

There are several proposals concerning the number and type of modalities that need to be recognized. Nevertheless, there seems to be a consensus regarding two: *epistemic* and *deontic* modalities. The former expresses the speaker's beliefs and degree of conviction concerning a given state of affairs, e.g., *He may be at home*. The latter expresses the speaker's permission or injunction that an act be performed or obligation fulfilled (Hoye, 1997), e.g. '*You may go home now*'. Some accounts of modality (e.g. Huddleston & Pullum, 2002; Palmer, 1990) also include a third type, *dynamic* modality, which is related to the ability and volition of the subject, e.g., *He can play the piano really well*. However, reservations have been expressed, even among those who include dynamic modality in their frameworks, as to whether ability and volition should be treated as modal notions, because modality is "essentially subjective …, for CAN and WILL merely make purely objective statements about the subject of the sentence, as do most other verbs" (Palmer, 2003: 36). Some frameworks (e.g. Coates, 1983) recognise two types of modalities, *epistemic* and *non-epistemic* (or *root*), the latter of which includes deontic and dynamic modalities.

A further dimension of modality is that of *degree* (Palmer, 1986: 102-103) or *strength* (Huddleston & Pullum, 2002: 176-179). In epistemic modality, this dimension is understood as the extent to which the speaker/writer is committed to the likelihood or factuality of what is expressed; in the case of deontic modality, it is the extent to which an action or event is presented as desirable. For example, *must* expresses a higher degree/strength of modality than *may*.

Modality can be expressed through a variety of formal means, such as modal auxiliaries (e.g. *may, ought to*), lexical verbs (e.g. *need, want*), adverbs (e.g. *possibly, probably*), constructions involving adjectives (e.g. *it is likely/possible that …*), the imperative,

and the past tense (in some contexts, e.g. conditionals). However, most accounts of, and studies on, modality focus on a group of nine modal auxiliaries usually termed *central modals* (*can, could, may, might, must, shall, should, will, would*). Formally, these auxiliaries share a number of properties, usually referred to by the acronym NICE (Huddleston & Pullum, 2002: 93):

(1) **N**egative form with *not/n't*[5], e.g. He **can't** come.
(2) **I**nversion with the subject to form a question, e.g. **Can** he come?
(3) **C**ode, e.g. She can come and **so can he**.
(4) **E**mphatic affirmation, e.g. He **may** come.

There is no consensus as to whether *could, might, should* and *would*, should be treated as the past forms of *can, may, shall* and *will* respectively or as modal auxiliaries in their own right. According to Celce-Murcia & Larsen-Freeman (1999), English modals are derived from verbs that carried tense and took agreement markers during a much earlier stage on the language. Thus, they argue that the historical derivation from ordinary verbs still has some semantic implications (see also Huddleston & Pullum, 2002: 92). However, other studies treat central modals not as present/past tense pairs, but as distinct modal auxiliaries. Quirk et. al. (1985: 147) remark that 'modals might without much simplification be regarded as "modal particles" which have lost their historical connection with the inflectional paradigm of verbs' (see also Biber et al., 1999: 483-485; Leech, 2004: 141-143).

From a distributional perspective, it seems that central modals are much more frequent in spoken than in written English, and that *will*, *would*, *can* and *could* are notably more frequent than the other modals (Quirk et al, 1985). Biber et al (1999: 486), in their major description of the distribution of modals in the 40-million-word LSWE[6] Corpus, also show that *will*, *would*, *can* and *could* are extremely common, with *shall* being the least frequent central modal. Kennedy (2002) reports similar results regarding the relative frequency of modal verbs in the BNC[7], with *will* accounting

[5] *Mayn't* is not a very frequent form, it occurs only seven times in the BNC.
[6] LSWE stands for Longman Spoken and Written English Corpus.
[7] BNC stands for British National Corpus (100million words of written and spoken English).

for almost 23% of all modal tokens in the corpus. Kennedy (2002) and Biber et al (1999) observe that the distribution of central modals varies according to genre or text type.

This study focuses on central modals for three reasons. Firstly, empirical studies indicate that, in writing, the expression of modality through this group of modals is more frequent than through other linguistic means (Gabrielatos, 2003;[8] Gabrielatos & McEnery, 2005: 320). Secondly, the fact that they are morphologically fixed makes them good candidates for a quantitative study on an unannotated corpus. Finally, and more importantly, central modals are normally polysemous, and, therefore, their examination in aviation manuals can provide an indication of the extent to which the guidelines regarding monosemy in simplified English are followed.

3 Corpus-based methodology

Corpus linguistics is empirical, in that one of its basic principles is the examination of naturally occurring language rather than introspective examples. However, this should not be taken to mean that in using attested examples as the basis of linguistic analysis one is necessarily employing a corpus-based methodology. A second, and complementary, principle is that of "total accountability" (Leech, 1992: 112); that is, the researcher must account for all the instances in the corpus of the linguistic phenomenon under investigation. The latter principle points towards a distinct characteristic of corpus-based methodologies,[9] that is, a focus on quantitative information and statistical analyses. For example, corpus studies frequently, if not invariably, take into account the frequency of occurrence of language features, and their distribution in spoken and written language and/or in different text types or genres. This is not to say that corpus linguistics does

[8] In a random sample of *if*-conditionals from the written sub-corpus of the BNC, 82% of the modalised main clauses contained central modals (Gabrielatos, 2003).

[9] There is some variation in the specific (combinations of) research procedures used within the corpus research paradigm (for a summary and examples see McEnery & Gabrielatos, 2006).

not involve qualitative analysis, rather that the quantitative analysis informs the qualitative interpretation of the data.

The existence of reference and specialised corpora makes it possible to compare the use of language features in specific domains in relation to language use as a whole. Similarly, comparisons can be made between different specialised domains. Krieger & Finatto (2004) mention the importance of corpus linguistics for terminological studies. The occurrence and distribution of linguistic elements reveals how productive the investigation of frequency, regularities and particularities in a large collection of specialized texts can be for the description of a specialised language and dictionary production. Bevilacqua (1998), Finatto et al. (2003), Hegedus (2005) and Maciel (2001) have also used a corpus-based approach in their research.

Although corpora are usually representative samples, it is not unfeasible, particularly in specialised domains, to create corpora which contain well defined entireties (McEnery & Gabrielatos, 2006: 34). For example, if one creates a corpus containing all aviation-related manuals of a specific company, one will be in a position to describe the language features characterising the language in the manuals of that company. As newly produced, or revised and updated manuals could be added to the corpus, it would be possible to examine how the use of specific language features in manuals develops over time. Also, a company interested in the linguistic standardisation of its manuals (as manuals are not typically written by the same author) could examine the sub-corpus containing manuals written for a specific purpose (e.g. quick reference in-flight manuals) to compare whether they all share the same linguistic characteristics. The availability of similar corpora containing manuals by other companies would make it possible to establish whether all manuals belonging to the same category (e.g. maintenance manuals) share the same linguistic characteristics, irrespective of the company which produced them. In other words, corpus-based research makes it feasible to establish whether a single standardised language for manuals exists. This, of course, can also be examined using samples, that is, only a few manuals from each company. In this case, however, conclusions would be less confident.

In this paper, comparisons are multi-faceted. First, the frequency of occurrence of the central modals in the Aviation Corpus is compared to that in a reference corpus. No information is given about the author(s) in the manuals; however, since they have been published by BOEING, an American company, it seems more likely that they were written by speakers of American English than speakers of any other variety of English. For this reason, we have decided to use a reference corpus of American English, FROWN (Hundt et al., 1999), for the comparisons of frequencies.[10] The distribution of central modals is compared across the three manuals comprising the Aviation Corpus. The analysis of AC and the comparisons with FROWN were carried out using *Wordsmith Tools* (Scott, 1998).

4 The Aviation Corpus

The Aviation Corpus (AC) comprises three BOEING 737 manuals: a maintenance manual (MM), addressed to aviation mechanics and technicians, consisting of 42,382 words, a Quick Reference Handbook (QRH), addressed to pilots, consisting of 29,928 words, and an Operations Manual (OM), also addressed to pilots, with 46,895 words - adding up to a total of 119,205 words. A corpus is not simply a collection of naturally occurring texts (spoken or written), but, ideally, a microcosm of a language or language variety, or, more precisely, "a finite collection of machine-readable texts, sampled to be maximally representative of a language or variety" (McEnery & Wilson, 2001: 197). Berber Sardinha (2002) considers a corpus of over a 100,000 words to be a small-medium corpus, which is deemed large enough to be representative in the case of specialised or simplified languages. However, given that the manuals comprising the corpus come from the same source, the quantitative information derived from the analysis should be treated only as an indication, and any conclusions need to be tentative. To put it differently, the information derived from the analysis of AC is contingent on the extent that the corpus is representative of the genre of aviation

[10] FROWN contains 1 million words of writing from different genres, and was compiled in the early 1990s.

manuals, and, more specifically, on the extent that the manuals comprising the AC are representative of aviation manuals of a similar type in general. Clearly, more studies on different aviation manuals are needed for more confident conclusions to be drawn.

The MM contains information required to service, troubleshoot, check, repair, and replace all systems and equipment installed in the 737-300/400/500 airplanes normally requiring such action on the line or in the maintenance hangar. In addition, it contains information about the inspection and maintenance of airplane structure. The OM provides the necessary operating limitations, procedures, performance, and systems information the flight crew needs to safely and efficiently operate the 737 airplane during all anticipated airline operations. It is structured in a two-volume format. Volume 1 includes operational limitations, normal and supplementary procedures, and dispatch performance data. Volume 2 contains systems information. The QRH consists of Normal and Non-Normal Checklists. Normal checklists are used to verify that certain procedural steps have been carried out. Only those steps which, if omitted, would have some impact on normal operations are included in the Normal Checklist section. Non-Normal Checklists, on the other hand, include information to be used by the flight crew to cope with emergencies. They contain instructions for corrective action, as well as information for planning the remainder of the flight. The 737 airplanes require two flight crew members, i.e., two pilots: a captain and a first officer. Each pilot calls for checklists according to their area of responsibility during the flight.

5 Analysis and discussion

The analysis will consist mainly of comparisons in the frequency of central modals, either taken as a group or individually, between the AC and FROWN, as well as between the three manuals comprising the AC. Since the corpora and sub-corpora are of different sizes, the comparisons need to be based on normalised frequencies – in our case, frequencies per 1,000 words. Also, in order to establish whether any observed frequency differences are due to the specialised language used in the manuals

rather than chance, we will also make use of the log likelihood (LL) statistic (cf. Rayson & Garside, 2000). A LL score of 6.6 and above, indicating that the probability of an observed difference being due to chance is less than 1% (i.e. indicating a level of confidence of more than 99%), will be considered as showing statistical significance.

5.1 *Comparison between AC and FROWN*

We will begin with a comparison of the frequency of central modals, taken as a group, in the AC and FROWN. The table below shows the actual frequencies as well as the normalised frequencies (i.e. frequencies per 1,000 words) in the two corpora. The final column indicates the log likelihood value.

Table 1. Comparison between AC and Frown
(freq. per 1,000 words)

AC	FROWN	AC (normalised)	FROWN (normalised)	*LL*
840	10,998	7.05	10.76	*158.02*

As a group, the central modals are used 50% less frequently in the AC than FROWN, and this difference is statistically significant. Taking into account the typical content of the manuals comprising the AC, which is predominantly factual information and instructions, we can speculate that the marked difference in frequency is due to the comparatively infrequent use of hypotheticality or hedging, that is, epistemic modality. However, we also need to examine whether, and to what extent, this general trend is shared by the individual modals. To that end, we compare the normalised frequencies of individual modals in the AC and FROWN (Table 2).[11]

[11] See Appendix 1 for the actual frequencies.

Table 2. Comparison of normalised frequencies of modals in the two corpora

	AC	FROWN	*Difference(%) AC-FROWN*	*LL*
can	1.82	1.86	*-2%*	*0.11*
could	0.18	1.62	*-800%*	*229.94*
may	1.95	0.86	*+56%*	*103.87*
might	0.02	0.62	*-3000%*	*121.44*
must	1.33	0.65	*+51%*	*55.15*
shall	0.01	0.14	*-1300%*	*25.38*
should	0.70	0.77	*-10%*	*0.78*
will	0.99	1.72	*-74%*	*40.21*
would	0.05	2.50	*-4900%*	*500.41*
Total	7.05	10.76	*-53%*	*158.02*

The comparison of individual modals reveals significant variations in their frequencies. Two modals, *can* and *should*, are used as frequently in the two corpora (the slight observed differences are not statistically significant). Five modals show lower frequency in AC, the most marked being *would, might*, *shall* and *could*. *Will* is also less frequent in AC, but the difference is significantly less marked in comparison. The much lower frequency of *would, might* and *could* in AC seems to support the explanation given above, that is, that the function of manuals requires little use of epistemic modality, as manuals mainly give clear-cut information and instructions. In fact, we can now expand our explanation by suggesting that the epistemic modality expressed in manuals is of a low degree, as *would, might* and *could*, which are virtually unused in the AC, express a high degree of modality, that is, a higher degree of tentativeness (e.g. Palmer, 1987: 44). Attitude to likelihood (epistemic sense) seems to be expressed in AC mainly through *may* (at least as far as the central modals are concerned), as *must* is used only with deontic meaning.[12] This can explain why *may* is used more frequently in AC than in FROWN.

[12] See Appendix 2 for the concordances with *must*.

5.2 *Comparison between manuals in AC*

The AC consists of manuals addressed to different audiences: mechanics and pilots. Also, the manuals for mechanics and pilots address different issues and procedures, and are to be used in different settings (hangar and cockpit) and under different conditions. It is not unreasonable, therefore, to expect that the differences in the contexts for which these manuals were written may be reflected in the language used in them, and in the use of central modals in particular. It seems wise, then, to examine the normalised frequencies of the central modals separately in the two types of manuals for a more accurate picture (Table 3 below).

Table 3. Comparison between manuals for mechanics and pilots

	Mechanics	**Pilots**	***LL***
can	3.49	0.90	*95.33*
could	0.26	0.14	*1.92*
may	0.61	2.68	*72.00*
might	0.05	----	*4.14*
must	1.75	1.09	*8.46*
shall	----	0.01	*0.88*
should	0.28	0.91	*18.05*
will	1.01	0.98	*0.04*
would	----	0.09	*6.15*
Total	7.45	6.80	*1.73*

The comparison between manuals for mechanics and pilots may show no statistically significant difference in the frequency of central modals as a group, but it reveals some marked differences in the use of individual modals. The MM contains *can* and *must* in significantly higher frequency than the pilots' manuals (OM + QRH),[13] whereas the latter show considerably higher frequency in the use of *may* and *should*. This comparison also sheds light into the source of the higher frequencies of *may* and *must* in AC, compared to FROWN. The higher frequency of *may* in AC is clearly due to the

[13] Although *could* is also used more frequently in MM, it will not be taken into account in the discussion as the difference is not statistically significance at the required level of confidence.

pilots' manuals (OM and QRH), whereas the higher frequency of *must* is mainly due to the mechanics' manual (MM).

The differences observed above point towards the utility of comparing the two manuals for pilots (OM and QRH) as well. The two manuals may share two contextual elements (namely, audience and setting), but they are supposed to be used in different circumstances. The OM contains directions for the normal procedures to be carried out before take-off, during the flight, and after landing. The QRH, apart from checklists for normal operations, also contains instructions for handling emergencies, something that may be reflected in the use of central modals (see Table 4 for the comparison results).

Table 4. Comparison between OM and QRH

	OM	QRH	LL
can	0.79	1.07	1.57
could	0.19	0.06	2.22
may	2.54	2.90	0.92
might	--	--	0.00
must	1.55	0.37	27.59
shall	0.02	--	0.99
should	1.02	0.73	1.72
will	0.74	1.33	6.33
would	0.04	0.17	3.03
Total	6.90	6.65	0.18

The frequency of the group of central modals is comparable in the two manuals for pilots, as comparable is also the frequency of all individual modals but one. The only modal that registers a statistically significant difference is *must*. At first glance, it seems counter-intuitive that *must* should be more frequent in OM, as one would expect the QRH, which provides instructions to handle emergencies, to contain as much, if not more deontic modality. However, informal observations during the analysis, as well as the examination of 3-gram[14] and 4-gram keywords, indicate that this difference may be due to the higher frequency of imperatives in QRH.

[14] 3-grams and 4-grams are strings of 3 and 4 words respectively; they are not necessarily grammatical or meaningful units.

5.3 *Relative frequency of central modals in AC*

In this section we examine more closely the relative frequency of modal verbs in AC, and compare it to that established in studies on general reference corpora (see Table 5 for a summary). Column 1 shows the modal forms analysed. Column 2 shows that 840 of the word tokens in AC are modals. Column 3 shows the percentage of each of the modals. *Will*, *can*, *may* and *must* account for 86.31% of all the modal verb tokens, with *may* being the most frequent (27.62%). The most frequent verbs in this corpus differ from those found in previous studies (Biber et al, 1999; Kennedy, 2002; Quirk et al, 1985) in which *will*, *would*, *can* and *could* were the most frequent. *Would* and *could* show a very low frequency in AC, with 0.83% and 2.62% respectively, if compared to the other cited studies. However, the low frequency of *might* and *shall* in AC (only one occurrence of *shall* and two of *might*) is comparable with that found by studies on reference corpora. For this reason, even though *shall* and *might* will always be included in the tables, they will not be usually referred to in the discussion.

Table 5 Distribution of Modal Verbs
in the Aviation Corpus (AC) %

1	2	3	4	5	6
	Tokens in AC	**Tokens in AC (%)**	**MM**	**QRH**	**OM**
can	217	25.83	46.69	16.08	11.42
could	22	2.62	3.47	1.00	2.78
may	232	27.62	8.20	43.72	36.73
might	02	0.24	0.63	0.0	0.0
must	158	18.81	23.35	5.53	22.53
shall	01	0.12	0.0	0.0	0.31
should	83	9.88	4.10	11.06	14.81
will	118	14.05	13.56	20.10	10.80
would	07	0.83	0.0	2.51	0.62
Total	840	100	100	100	100
Modals per 1.000 words		7.05	7.47	6.64	6.91

Columns 3, 4 and 5 show the distribution of modals in the three different manuals. *Will* is more frequent in the QRH, with 20.10% compared to 13.56% in the MM, and least frequent in the OM (10.8%). There is clearly a much higher proportion of *can* in the MM, nearly half of all the modal verb tokens in the whole manual

(46.69%), compared to 16.08% in the QRH and 11.42% in the OM. The QRH shows approximately five times more occurrences of *may* than the MM, with 43.72% and 8.20% respectively. *Must* is much more frequent in the MM (23.35%) and in the OM (22.53%), showing a frequency about four times higher than in the QRH (5.53%). There is also a substantial variation in the frequency of *should*, with a relative frequency of only 4.10% in the MM, about three times higher in the QRH (11.06%) and more that three times higher in the OM (14.81%).

5.4 *Modal verb phrase structure in the AC*

Although modal verbs can occur in nine different verb phrase structures (see Table 6, from Kennedy, 2002), only a few of them are present in AC.

Table 6 Possible modal verb phrase structure
(Kennedy, 2002:82)

1	Modal alone	(Who will go?) I *will*.
2	Modal + infinitive	Sam *can* swim./ She *must* be hungry./ You *should* have a rest.
3	Modal + be + past participle (Modal with Passive)	It *should* be replaced.
4	Modal+be+present participle (Modal with Progressive Aspect)	They *will* be arriving soon.
5	Modal+have+past participle (or adjective)	He *might* have done it. He *must* have been hungry.
6	Modal+be+being+past participle (or adjective)	It *might* be being done tomorrow. He *could* be being awkward.
7	Modal+have+been+past participle (Modal with Passive and Perfect Aspect)	It *should* have been fixed.
8	Modal+have+been+present participle (Modal with Perfect and Progressive Aspect)	He *must* have been lying.
9	Modal+have+been+being+past participle (or adjective) (Modal with Passive and Perfect and Progressive Aspect)	He *might* have been being blackmailed. They *must* have been being careless.

According to Kennedy (2002: 82), "there are huge differences in the relative distributions of use of the nine structures" in the BNC. Structure 2, modal+infinitive, accounts for 76% of all modal occurrences. The proportion is even higher in the spoken texts (84,9%). Biber et al (1999) argue that some modals have a higher occurrence with marked voice or aspect. In their

findings, *may*, *might*, *should* and *must* have a higher frequency with perfect aspect.

Table 7 shows the distribution of the modal verb phrase structures in the three different manuals in AC. As can be seen, distinct differences in the distribution of the nine structures are also present here, supporting the variation found in Biber et al. (1999) and Kennedy (2002). Structures 1, 6, 8 and 9 have no occurrences at all in any of the three sub-corpora. Structures 4, 5 and 7 have a very low frequency, accounting for only 1.08% of the modal tokens in the AC as a whole. Structure 2 (modal+infinitive) together with structure 3 (modal+be+past participle) account for 98.92% of the occurrences (56.90% and 42.02% respectively). The frequency of structure 2 (modal+infinitive) in the MM matches that of the BNC. However, both the QRH and the OM, have a higher occurrence of structure 3 (modal+be+past participle) than of structure 2, which does not correspond to the findings of Biber et al (1999) and Kennedy (2002).

Table 7 Modal verb phrase structures
in the different manuals%

	Modal structure	AC	MM	OM	QRH
1	Modal alone	0.0	0.0	0.0	0.0
2	Modal + infinitive (present infinitive, active voice)	56.90	74.45	45.06	48.24
3	Modal + be + past participle (present infinitive, passive voice)	42.02	24.29	54.01	50.75
4	Modal + be + present participle	0.36	0.0	0.31	1.01
5	Modal + have + past participle	0.24	0.31	0.31	0.0
6	Modal + be + being + past participle	0.0	0.0	0.0	0.0
7	Modal + have + been + past participle	0.48	0.95	0.31	0.0
8	Modal + have + been + present participle	0.0	0.0	0.0	0.0
9	Modal + have + been + being + past participle (or adjective)	0.0	0.0	0.0	0.0
	Total	100	100	100	100

Whereas Table 7 shows the distribution of the modal verb phrase structure in the different manuals, Table 8 presents the ex-

tent to which different modals make use of the verb phrase structures.

Table 8 Distribution of modal verbs
in verb phrase structures of the AC

	Modal structures	*can* %	*could* %	*may* %	*might* %	*must* %	*shall* %	*should* %	*will* %	*would* %
1	Modal alone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Modal + infinitive	64.52	95.45	51.29	0.0	46.20	100	32.53	77.97	71.42
3	Modal + be + past participle	35.48	0.0	46.99	0.0	53.16	0.0	67.47	21.18	28.58
4	Modal+be+present participle	0.0	0.0	0.86	0.0	0.64	0.0	0.0	0.0	0.0
5	Modal+have+past participle	0.0	0.0	0.43	0.0	0.0	0.0	0.0	0.85	0.0
6	Modal+be+being+ past participle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	Modal+have+been+ past participle	0.0	4.55	0.43	100	0.0	0.0	0.0	0.0	0.0
8	Modal + have + been + present participle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Modal + have + been + being + past participle (or adjective)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	100	100	100	100	100	100	100	100	100

Will (77.97%), *would* (71.42%), *can* (64.52%), *could* (95.45%) and *may* (51.29%) are mostly used in structure 2. On the other hand, *should* (67.47%) and *must* (53.16%) have a higher proportion of their tokens in structure 3 (modal + be + past participle) than the other modals. Both *should* (95%) and *must* (100%) have a high proportion of deontic uses with agent deletion. For example: *Handle should be folded inside stabilizer trim./ Landing must be accomplished with one engine*.

Something to be noted is that in both the QRH and OM (the two manuals addressed to pilots) 60.71% of the occurrences of *must* occur in structure 3 (must + be + past participle) with agent deletion, whereas the proportion of modal tokens in structure 3 in the MM is 44.60%. Also, 81.82% of the occurrences in structure 2 have the pronoun *you* in the MM (i.e., '*you*+*must*+infinitive). For example: *You must do an inspection of all tubes.* Neither the QRH nor the OM have any instances with the pronoun *you*. In these latter manuals, when *must* is in structure 2, the subject is impersonal, e.g. *ADIRU alignment must not exceed 453 Kgs for taxi or takeoff*. Throughout the MM, there are 51 occurrences of you + modal, or 16.09% of the cases, as compared to none in the other two manuals, QRH or OM.

Table 9 shows the extent to which each individual modal contributes to the total number of tokens of modal use for each of the modal verb phrase structures. For structure 2 (modal + infinitive), 73.44% of the modal tokens come from *will*, *can*, and *may*, with 19.25%, 29.29% and 24.90% respectively. Even though *may* is a more frequent modal verb than *can*, the latter is more used in the non marked form, or structure 2. Also, it is important to point out that 68.2 % of the total *can* tokens occur in the MM, which, overall, shows a preference for structure 2. In structure 3 (modal+ be+ past participle), it is *may* (again) which contributes the highest proportion (30.88%) of the modal tokens, followed by *must* (23.80%) and *can* (21.81%). *May*, on the other hand, is much more frequent in the two manuals for pilots, the QRH and the OM, with 88.79% of the occurrences.

Table 9 Distribution of modal verbs
in verb phrase structures of the AC

Modal structures	Tokens in AC	Can %	Could %	May %	Might %	Must %	Shall %	Should %	Will %	Would %
1 Modal alone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 Modal + infinitive	478	29.29	4.39	24.90	0.0	15.26	0.21	5.65	19.25	1.05
3 Modal + be + past participle	353	21.81	0.0	30.88	0.0	23.80	0.0	15.86	7.08	0.57
4 Modal+be+ present participle	3	0.0	0.0	66.67	0.0	33.33	0.0	0.0	0.0	0.0
5 Modal+have+ past participle	2	0.0	0.0	50.00	0.0	0.0	0.0	0.0	50.00	0.0
6 Modal + be + being + past participle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 Modal + have + been + past participle	4	0.0	25	25	50	0.0	0.0	0.0	0.0	0.0
8 Modal + have + been + present participle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 Modal + have + been + being + past participle (or adjective)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	840									

6 Conclusion

The analysis of the AC confirms the findings of previous studies on larger corpora, i.e. that there is a great deal of variation in the use of modal verbs and the structures they occur in, depending on the context of use. First of all, there are differences in the use of individual modal verbs, especially when compared to

the findings of other studies (Biber et al., 1999; Kennedy, 2004). The most striking difference concerns the use of *would*, which, although very frequent in other corpora (e.g. 39.8% in Kennedy, 2002), are extremely rare in AC, accounting for only 0.83% of modal tokens. There are also differences between the three manuals. *Can* is much more frequent in MM, *may* in both QRM and OM, *must* in MM and OM, and *will* in QRH. As in the other studies, there is a clear preference for structures 2 (present infinitive, active voice) and 3 (present infinitive, passive voice). However, in this corpus, structure 3 has a higher frequency than that established in studies on representative large corpora (Kennedy, 2002; Biber et al, 1999). If we analyze each manual separately, the difference is even higher. As mentioned before, MM has a higher use of structure 2, but QRH and OM have more occurrences of structure 3 than structure 2, 50.75% and 54.01% respectively.

These findings show that there are substantial differences even within the AC, with each manual demonstrating distinct preferences. According to the analysis, QRH and MM present more differences between them, whereas OM is situated between the other two. As far as the training of manual authors is concerned, this study suggests that the idiosyncrasies of each type of manual should be taken into account when preparing pedagogical material. The term *aviation manual* may be a convenient, even useful, umbrella term, as aviation manuals share common characteristics relative to other genres. However, the different patterns of use observed in the three manuals comprising AC suggest that it would be wise to keep in mind that the term may also obscure the fact that aviation manuals differ in their context of use. To be more precise, their variation may be ascribed to the influence of three interrelated contextual aspects: their intended *audience* (e.g. mechanics or pilots), their intended *purpose* (e.g. maintenance or operation), as well as the nature and urgency of the *conditions* under which they are normally used (routine or emergency). Different combinations of these aspects will result in manuals with different characteristics. For example, the high frequency of the structure '*you*+modal+active inf.' in the mechanics' manual contrasts sharply with the total absence of this structure in

the pilots' manuals. Table 10 below demonstrates how these three aspects of context characterise the three manuals in AC.

Table 10. Interaction between context of use and type of aviation manual

Audience	Purpose	Conditions	Manual
mechanics	maintenance	routine	MM
mechanics	repair	routine	MM
pilots	operation	routine	OM
pilots	operation	emergency	QRH

As far as Specialised English is concerned, the examination of central modals in the AV provides evidence that the language of aviation manuals is simplified in comparison to other written genres. More specifically, there were three indicators that clarity of expression, which is expected to facilitate ease and speed of comprehension, is of primary importance in the language of aviation manuals. The first indication was the tendency towards monosemy in the use of central modals. Seven out of nine are used in only Epistemic or Root meaning, the exceptions being *can* and *should*, which express either modality type in the corpus. Two more indications of simplicity were observed in terms of structure. In almost all cases (98.9%) the central modals in AC are followed by the present infinitive, active or passive (structures 2 and 3 respectively), which are the simplest forms that infinitives in each voice can take. Finally, there were no instances of infinitive ellipsis (structure 1), which can be taken as an indication that the authors avoided taxing the memory of users.

The predominantly quantitative examination of the variation of the distribution of central modals in AC is only a starting point. To improve the reliability of results, the compilation and examination of a larger corpus is required. To that effect, permission to add more manuals has already been secured, and permission to use further manuals will be sought. To improve the representativeness of the corpus, the AC will be expanded so that it contains multiple examples of all existing types of aviation manuals. The analysis itself will have to extend to all modal expressions used in the corpus, and a more detailed examination of the distribution of modality types. Further studies should also

focus on the use of central modals with active and passive infinitives, as well as the collocation patterns of modal expressions in the corpus, such as verb collocations of central modals.

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8 Appendices

Appendix 1.
Frequencies of central modals in AC and FROWN

	AC (119,205)	MM (42,382)	QRH (29,928)	OM (46,895)	QRH+OM (76,823)	FROWN (1,022,136)
can	217	144	18	31	49	1905
could	22	11	2	9	11	1654
may	232	26	87	119	206	878
might	02	2	--	--	--	632
must	158	74	11	73	84	667
shall	01	--	--	1	1	149
should	83	12	22	48	70	787
will	118	43	40	35	75	1763
would	07	--	5	2	7	2563
Total	840	317	199	324	523	10,998

Appendix 2. Abbreviations

AC	Aviation Corpus
BNC	British National Corpus
CTT	Communicative Theory of Terminology
GGT	General Theory of Terminology
MM	Maintenance Manual
OM	Operations Manual
QRH	Quick Reference Manual
FROWN	Freiburg-Brown Corpus of American English
LL	Log Likelihood
LSWE	Longman Spoken and Written English Corpus
SE	Simplified English

Appendix 3. Concordance lines with *must*

1	Prior to each flight, the flight crew	must	accomplish or verify th
2	e may be performed if the flight crew	must	accomplish preflight ac
3	trols OY-MRA -OY-MRC 2 LOWER LADDER	MUST	AIRSTAIR OPERATION
4	and RADIAL/DIST (REF IDENT identifier	must	already be stored in
5	w created waypoint (place identifiers	must	already be stored in
6	rplane course, vertical path, and speed	must	always be monitored.
7	to make the alkaline neutral. (e) You	must	always wear protective
8	tion to make the acid neutral. (e) You	must	always wear protective
9	he safest course of action. The captain	must	assess the situation a
10	d lower ladder safety circuits. Caution	must	be exercised when usi
11	r standby operation, the battery switch	must	be ON. Hold until exte
12	ng conditions are present, takeoff roll	must	be preceded by a static
13	res inflict performance penalties which	must	be taken into account on
14	tolerance for within balance Elevator	must	be assembly. ____ NOT
15	tolerance for within balance surfaces	must	be Balanced control (SRM
16	y between structural members, the parts	must	be disassembled and repla
17	tolerance for within balance Aileron	must	be re-balance aileron.
18	flap components and related structures	must	be ú examined for damage a
19	there is damage to the valve, the valve	must	be ____ replaced. (a) Lo
20	eel and tire assembly, and the bearings	must	be ____ sent to the sh
21	eel and tire assembly, and the bearings	must	be ____ sent to the sh
22	RNING: THE POWER CABLE OF THE BORESCOPE	MUST	BE IN A GOOD C
23	RNING: THE POWER CABLE OF THE BORESCOPE	MUST	BE _____ IN GOOD CON
24	ane is stalled, recovery from the stall	must	be accomplished first by a
25	. Recall items are critical steps that	must	be accomplished from memor
26	e SID or Runway This entire procedure	must	be accomplished when a SI
27	INOPERATIVE LANDING Condition: Landing	must	be accomplished with one
28	..... ON Passengers	must	be advised to fasten seat
29	tches Note: AC and DC electrical power	must	be available on airplane.
30	ve, and the crossfeed valve. AC power	must	be available. To transfer
31	nt during approach or landing. Pilots	must	be aware that checklists
32	ight or landing. Fuel crossfeed valve	must	be closed for takeoff and
33	erational Information APU bleed valve	must	be closed when: • ground
34	..... Set Note: IRS alignment	must	be complete. EFIS – Cor
35	.....Set Note: IRS alignment	must	be complete. EFIS – Cor
36	by mode, the momentary standby switch	must	be depressed while the ret
37	ration associated with control surfaces	must	be diagnosed and repaired
38	off below 400 feet AGL. The autopilot	must	be disengaged before th
39	. (e) Inspection, clean-up, and repair	must	be done before the next
40	l _____ A. This inspection procedure	must	be done when the airplane