INTERNATIONAL AVIATION ENGLISH ASSOCIATION

Editor: Philip Shawcross **December, 1995, N° 6**

EDITORIAL

The permanent increase in technical reliability and safety within aviation have led man to the sometimes painful realisation that he should pay more attention to himself as a link in the chain of causality. In the last ten years Human Factors have migrated from Ph.D these to occupy an inalienable place in the aviation industry. It was in recognition of this fact that the last International Aviation Forum was held in March 1994 in Paris on the theme: People, Flying Machines and English: the human factors. Many fascinating avenues were opened up; indeed Claire Pélegrin of Airbus Training addressed the forum on the subject of Crew Resource Management. We felt however that so small a coverage for so important a subject was not tolerable. So, when Airbus Training accepted to host a seminar on this subject in Toulouse in February 1995 we were overjoyed.

I feel that a word should be said here about the extremely supportive role that Airbus has played in the Associations activities right from the beginning. Hans Uhl must be mentioned for the very personal mark of kindness & efficiency he brought to our first two seminars in Prague and Helsinki. We are similarly endebted to Eddy Rocca and Claire Pélegrin for the generosity & inspiration with which they devoted themselves to making sure the seminar in Toulouse would be an outstanding success, both through their painstaking preparation and their contributions as speakers. Naturally, none of this would have been possible at all without the encouragement of Pierre Baud, Vice-President Training & Flight Operations Support Division. The Association would like to express their gratitude

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THE BACKGROUND TO CRM

Eddy Racca.

After a 30-year career as a flight test pilot and flight test engineer, Eddy Racca has for the past few years been Human Factors Training Manager at Airbus Training.

The Videos

Eddy Racca began his presentation by showing a video used at Airbus Training as an introduction to the CRM course. It consisted of two sequences filmed in the simulator a crew managing an engine failure and turn-back in flight. The first sequence is almost a caricature of poor crew relations, lack of communication and mismanagement of resources leading to a disregard for ATC instructions. It is designed to spark awareness of the importance of human factors at the beginning of the course.

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EDITORIAL (contd.)

and their feelings of having been most privileged.

This feeling was reflected, I believe, in the quite exceptional attendance in Toulouse last February, both in numbers and in wide spread of countries represented. The event was an example of what can be done with a little determination and good will.

In this number of the Newsletter there is a report on the proceedings of 16th and 17th February. In addition to Eddy Racca's and Claire Pélegrin's important presentations on CRM, we were more than fortunate in having Peter Harrigan of Saudi Arabian Airlines share with us his experience of CRM training from the airline's point of view, of the cross-cultural implications and communicative skills for cabin crew in two papers of the highest quality. The picture would have been incomplete without Alain Sabatier's insights as a flight simulator instructor at Airbus Training with flight crews from all around the world.

We are pleased to be able to review Peter Cushing's book "Fatal Words: Communication Clashes and Aircraft Crashes", which sheds valuable light on the issue of human factors. The Newsletter also contains the conclusion of Denis Philips paper on Linguistic security and Kitka Toncheva's article on Blending in aviation terminology.

By way of a post scriptum, may we remind you of the obvious: that the Association can only fuel itself on your ideas, letters, articles and questions for the Newsletter and your suggestions and invitations for forthcoming seminars. ■

THE BACKGROUND TO CRM (contd.)

Another video, not shown at the seminar, demonstrates how even the First Officer in his subordinate position can affect the course of events with an uncooperative captain by politely drawing the captain's attention to what he is doing with expressions as simple as, "Excuse me, Captain, but I have to finish what I am doing.

At the end of the day the second video shown at the seminar is played to the trainees. It shows how the same situation could be handled in a more effective way in better communication and work sharing. The film demonstrates in a concrete way how human behavior and cockpit atmosphere can have direct repercussions on technical performance. The old divide between technical and human factors is a thing of the past. Nevertheless in certain cultures the familiarity (use of first names) and politeness ("Are you ready?" "Please." "Thanks." etc.) which characterize the crew's relationship in the last video may seem superfluous or out of place.

The films were made by Americans and bear the mark of American culture. It was clearly a dramatization and cultural coloring of the film was quite distinct (a point returned to in E. Racca's second address on the future of CRM).

A pilot must follow all the procedures laid down in the FCOM and flight manual, quite strictly; the roles of pilot flying (ensuring the flight path, handling, etc.) and pilot non-flying (monitoring, radio, etc.) are complementary and clearly defined. The first video demonstrates how poor CRM leads to procedures not being respected.

It was pointed out that in the second video communication is also more effective because intonation is used and the speech is more incisive with the keywords being isolated. Expressions like "select - pull" were said in the very deliberate way. The voice accompanies and supports the steps. Good behavior and good language combine. The first officer is also given enough time to finish each action instead of being overloaded by a continuous string of orders. A certain friendliness or warmth in crew relationships enhances good communication by creating an atmosphere of mutual trust and results in a reduced and better managed workload.

The two-man crew has changed the working environment very considerably, especially on long-haul flights. A relationship of authority where at critical moments it is the Captain who is the "boss" does not exclude the coexistence of more informal, friendly relations. The "tu" form or first name terms are generally used between flight crew members are the mark of belonging to the same profession. Similarly, from a technical point of view, both vertical and horizontal relations co-exist; the Captain has the ultimate authority, but all the tasks can be performed by either pilot and as pilot flying the first officer may give orders to the Captain.

Why CRM?

Cockpit Resource Management, as it was first known, was developed in the United States from the late seventies following a number of fatal accidents where technical factors were not the primary cause. One such accident (cf. National Transportation Safety Board Report N_ AAR-73-14) involved an Eastern Airlines L10-11 which descended into a swamp near Miami in 1972. It illustrates how a very minor technical problem, aggravated by an incorrectly phrased question, can result in the crew completely neglecting the flight path.

After a very straight forward flight, upon gear extension during descent over Florida the crew observed that the nose gear downlock green light did not illuminate. Now, this light is fitted with twin bulbs separated by a

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THE BACKGROUND TO CRM *(contd.)*

partition so that when one fails it becomes immediately apparent from the outside. For some reason, the bulbs had been installed without the central partition and both bulbs had failed without it being noticed. While they were investigating the failure, the crew obtained permission to hold at 2,000 ft. The tape from the Cockpit Voice Recorder makes it clear that all three crew members became completely absorbed with checking and replacing this indicator light and did not observe that the autopilot had disengaged and that they were descending. They found it difficult to replace the light cover. Everyone tried. At 900 ft. ATC called the plane asking "What are you doing?", instead of asking them why they were at 900 ft. As they were focused on the problem of the indicator light they answered that there was no problem, the were just fixing the light. As in this area the radar was sometimes unreliable, giving faulty, altitude indications, the controller disregarded the information on his screen. The airplane continued to descent. At around 300 ft., the altitude alert sounded by the crew was so intent on replacing the light cover that they did not pay attention to the warning. Very close to the ground the altitude alert sounded again. The first officer asked what the matter was. The captain said that it was the altitude, but it was too late to pull up and the plane cashed into the swamp with considerable loss of life.

Such events as this spurred human factors studies and the advent of CRM courses in many airlines. Airbus Industrie was the first manufacturer to introduce CRM in their transition training.

When a crew flies an airplane, they must respect "operational integrity", i.e. factors such as safety, efficiency, schedule, comfort, regulations and operational specifications. This is ensured by the crew's performance. The crew's performance can be roughly divided into two parts: the technical part and the human factors. Until the mid seventies, attention was focused on the technical aspect. Pilots were trained to an extremely high level of technical proficiency. Accident investigations however demonstrated that purely technical considerations were at the root of approximately only 30% of all aircraft accidents/incidents. By far the largest number of accidents/incidents were related to human factors, originally called "pilot error". An accident is never the result of a single cause. Human factors is one way of allowing the creation of a more sophisticated and realistic model of causality and so a better understanding of the interaction of those factors that may be at the source of many aircraft accidents. ■

Some of those who attended the seminar in front of the Airbus Training building, 17th February 1995

For reference:

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OPERATIONAL TEAMBUILDING IN AN INTERNATIONAL AIRLINE

Multi-Cultural Liveware Needs Multi-Skills Training

Peter Harrigan.

Peter Harrigan, who is the subject of our PORTAIT in this issue, has been a training specialist for Saudi Arabian Airlines since 1981.

« Human factors is the applied science which studies people working together in concert with machines. »

FAA advisory circular:
« Crew Resource Management ».

Human factors have had particular relevance for Saudi Arabian Airlines for a long time now. Captain Majid Kabbani started his pioneering work in CRM training as far back as 190 and, as this paper will make clear, human factors awareness plays a vital role in training throughout the airline.

The environment

Saudi's operational and human environment explains the airline's concern with factors involved in safety and efficiency which are other than technical. The airline operates a worldwide network of 44 international and 24 domestic stations, carrying 12 million passengers yearly with a fleet of 747s, L1011s, Airbus and 737, with delivery of 23 B 777-200s and 29 MD 90s scheduled to begin in 1997. Cultural, linguistic, social and religious diversity is the outstanding feature of both passenger and staff. Saudia caters for pilgrims, workers, millionaires, families, businessmen and leisure travellers with a staff of 25,000. The thousand flight deck crew members represent 39 nationalities ; the cabin attendants come from 50 different countries. The pre-flight briefing brings together each time a unique crew combination where each member has to recognize and adjust to the behavioural norms of the others.

SAUDIA's approach

Saudia has had to face the challenge of managing such diverse and heterogeneous groups so that they can operate flights safely, knowing that an aircraft is a very poor communication environment and that passenger profiles vary drastically from sector to sector. Among the initiatives taken haven been :

- an overriding focus on standardisation in all operational areas,
- human factors training for flight instructors,
- an evolving programme of CRM training developed since 1980 by the Flight Operations Training and recognized b the FAA and IATA,
- a gradual extension of CRM, Company Resource Management, with a systems approach to human factors,
- creation of a Human Factors Unit in 1992,
- the enhancement of a corporate culture (« Proud to serve you ») through 600 courses given to the 25,000 staff n 45 locations,
- English language training for all Saudi operations staff,
- crew training in stress management, sleep management, relaxation techniques, brain maintenance,
- management programmes in areas such as interaction skills, decision-making, situational leadership, accelerated learning, change management, etc.

Although multi-cultural, multi-national work groups may take longer to achieve effective production than culturally homogeneous groups, once they have overcome the complexities of this working environment the results are often better.

Acceptance of CRM

It has taken some time to overcome an initial resistance to CRM training. Crews were often suspicious at the start. It was essential to make clear that CRM is :

- **not** a substitute for technical training !
- **not** a challenge to the captain's authority !
- **not** a static concept !
- **not** the whole of human factors !
- **not** a quick fix for safety concerns !
- **not** hot tub psychology for flight crews !

Analysing concrete case studies and their own experience in the light of the principles of CRM soon brings home to people that there is room for improvement in behavioural and inter-personal skills.

CRM trends

Due to the hiring of younger staff and technological change, experience levels of airline operations staff are diminishing while airline operations are expanding. In the USA commitment to CRM is deep and growing. The FAA advisory now recommends a fully integrated, comprehensive program of CRM for crews.

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OPERATIONAL TEAMBUILDING IN AN INTERNATIONAL AIRLINE *(contd.)*

CRM is also rapidly extending to regional, commuter and private aviation. The FAA proposed in November 1994 that commuter and regional operators conduct CRM training : 150,000 PIC's, first officers, flight attendants and flight operations officers.

Elsewhere, emerging airlines in former USSR and Asia for instance place new and extreme pressure on an already overloaded world ATC system ; limited English skills are a common factor and challenge.

Geographical and linguistic differences, however, are not the only variables forcing the airlines to pay attention to human factors :

- the percentage of female pilots (current 6% in the USA) is expected to increase over the next few years;
- the 2-man crew has profoundly modified crew relations and workload management;
- flight management control and display units capture a vast amount of the crew's attention : « cockpit vacuum cleaners - the suck eyeballs and fingertips right into them ».

These are just some of the features which are constantly changing the shape and scope of CRM.

The general trend in CRM is definitely towards a widening coverage from cockpit crew to cabin crew to operational staff, ground mechanics and management. Continental Airlines runs Crew Coordination Concept training for 7,000 maintenance staff.

CRM Content

Personality factors can seriously limit effectiveness of CRM raining. Operational staff need strong interpersonal skills and to develop their awareness of their own behaviour and attitudes. Advocacy or assertiveness training must be further developed - 679 lives could have been saved if junior crew members had pressed their opinions home more forcefully.

Video coverage of discussion topics is helpful for individual review, for follow-on sessions and self study. It is also low cost. In CRM training methodology practice, simulations and informal workshops appear preferred. Handouts and straight lecturers are inadequate. Human factors involves the methods and principles of both behavioural and social sciences, language, engineering and physiology.

« To better explain the relationship between these many disciplines, ICAO has adopted the SHEL model : S=software (procedures, symbology, etc.) ; H=hardware (machinery, equipment, etc.) ; E=environment (external and internal) ; and L=liveware (the human element). The interactions in this model all affect the center and, hence, the interfaces of LH, or liveware-hardware ; LS, or liveware-software ; LL, or liveware-liveware ; and LE, or liveware-environment. Every element of human factors and CRM can be expressed by considering these interactions.

For example, the LH interface would consider control and display design leading to common errors in interpretation, especially in the new glass cockpits. Personal comfort, cockpit visibility, motor workload and warning systems are added factors.

The LS relationship is in regard to standard operating procedures and their benefits, as well as written materials with errors in interpretation of maps, charts and checklists. This is also the area of the operational aspects of automation, including situation awareness, workload and interpretation.

The LE interface considers the internal comforts or discomforts such as temperature, noise, vibration, lighting, etc. The external part looks at terrain, weather, time of day and other traffic.

The LL relationship is the situation whereby CRM is incorporated using insight and skills of interpersonal actions - communication, problem-solving and decision-making - plus using all resources and crew-members available. Often a major part of the very well-recognized term called « pilot error», the LL interface is probably the most important, and flight crews are likely to respect it the most among all of the other interrelationships. » (in « *Fit for Flight* ». Vol. 74, N°2, p.90, Feb. 1994)

CRM and English language

In the United States itself, there is a growing recognition of language implications in CRM ; in 1994, the NASA's Voluntary Aviation Safety Reporting System contained a 6-inch (15 cm) thick file of language-related incidents. Response to the situation may, however, be somewhat simplistic, as is witnessed by the Aviation Week and Space Technology editorial « Upgrade Pilot English Standards » on November 7th, 1994 : « Enforcement will be a challenge. But short, simple language competency checks can be developed using inexpensive, automated desktop training devices. Tests need only be repeated on an annual basis... »

Culturally, hence linguistically, more complex environments may engender more far-reaching research in this direction. One of the by-products of human factors studies is a wider realisation as to just how language is interwoven with factors such as body language, eye contact, cultural awareness, humour, etiquette ;personality, interpersonal skills, etc.

A apparently trivial example may serve to illustrate the point. A flight attendant asked by the captain to bring him « coffee and creamer » reappeared in the cockpit a few moments later brandishing a bright yellow life-vest, not having understood the American term « creamer ». The incident occurred during cruise. Had it occurred during a period of high workload, the sudden appearance of this incongruous yellow object would have captured the crew's attention and considerably added to their level of stress.

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OPERATIONAL TEAMBUILDING IN AN INTERNATIONAL AIRLINE... *(contd.)*

The point is that poorly trained staff who interact with cockpit crew can act as sensory vacuum cleaners ; they can suck in the pilot's attention causing additional misunderstandings and stress. Staff working with flight crew need a high level of interpersonal skills and an awareness of CRM concepts. Pure language training is not enough. A multi-skills approach is necessary to build a solid base of competency in interaction, communication, language and etiquette, including cultural awareness.

Opportunities

Human factors, and its component CRM, offer a treasure trove of multi-dimensional opportunities for language specialists, trainers and materials writers. They also point to the necessity of a greater integration of language and technical and other professional training activities. If it is true that the role of language has probably been understated, it is no less true that language specialists have not paid enough attention to factors such as culture, personality, technical constraints, etiquette, stress, etc. whose essential part in the error chain is better known today.

Further reading in the press, etc. :

- *Aviation Daily, January 6th 1995*

  « NTSB Commuter Survey Shows Wide Variances in CRM Training »

- *Business and Commercial Aviation, January 1995*

  - « CRM Update » by Robert B. Parke
  - « What is CRM and Where can I learn more about it ? »

- *Airworth Aircrew, a monthly newsletter written and published by Richard O. Reinhard M.D., covering CRM, health and physiology*

- *Videotape of debriefing of Flight 232 (Sioux City accident) from :*

  Cal Hutchings
  Crew Leadership Resources Department
  United Airlines Flight Center
  7401 Martin Luther King Blvd
  Denver CO 80207

- *The Weekly of Business Aviation, December 19th, 1994*

  FAA proposes to merge part 121/135 training requirements, mandate CRM training

- *Business and Commercial Aviation, February 1994*

  The Human Factors of CRM

- *Air safety week, March 21st 1994*

  Pilot error, poor CRM skills cited in inflight upset injuring 13. ■

REFERENCES

The literature on CRM and related topics abounds and any serious bibliography would itself occupy the whole Newsletter. All we can attempt to give here are a few significant titles which will in turn serve as keys to more doors, containing as they do extensive bibliographies.

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ANSWERS TO THE QUIZ IN ISSUE N° 5

glider, doghouse, payload, light-up/light-off (paradoxically), doppler effect, terminal velocity, isobar, craze/crazing, vortex generators, altitude.

HUMAN FACTORS STUDIES IN AIRBUS TRAINING

Influences of Culture and Language on Pilot Training

Claire Pélegrin.

Claire Pélegrin trained as a psychologist and works in Human Factors, Training Standards and Quality at AIRBUS Training.

Claire Pélegrin began her presentation by telling us about a database she has set up to help in the follow-up of the transition course by providing information about the trainees and to draw attention to different aspects of the trainees' backgrounds which could have an influence on their performance in the training program.

*She went on to speak about the cultural elements studied, insisting that these aspects have an influence on **all** aspects of the flight. Her definition of culture included geographical origin, type of society the trainee comes from (modern...), procedure of the airline ('French' or 'American'), level of English and the language used in the country.*

Claire Pélegrin concluded by explaining why progress is hindered when people do not have sufficient mastery of English. When this is the case, the trainees say only what they have to say, do not ask questions or give any extra information. Up to now, it has not been taken into account that pilots may need training in English before they begin their transition course. Proficiency in English can have an effect on the instructor's work also. Capacity in English to give only the technical content of a course is sometimes not enough.

Objective

Cosynus, the database created within AIRBUS TRAINING, containing information about the trainees undergoing training at the center is designed :

- to provide the Airbus Training staff and the human factors department with statistical information about different trainee characteristics,
- to serve as tool for improving the standardization of the terms of reference and strategies between the instructors,
- to provide the instructors with a means of inference on new trainees as to their future performance. This individual inference is based on the trainee's personal background, culture, age and many other relevant variables.
- to anticipate difficulties so as to personalize the training process and avoid failures,
- to be used as a way of improving the content and organization of the course itself,
- to provide the marketing and sales staff with assistance in responding more appropriately to customers' needs.

Data

The background information entered in order to obtain these results includes :

- age
- nationality
- airline company
- cockpit position
- total flight hours
- hours flown on the last aircraft
- last aircraft type
- licence
- culture.

Taking two of these variables (age and hours flown on last aircraft) as examples, the following conclusions were reached :

As regards age :

- The youngest pilots, although they have no trouble in exams, have substantial trouble in all areas of flight. The areas in which they have fewer problems are related to supporting the pilot flying, which is their regular role at this age. They also have better scores in computer management (FMS, ECAM). Conversely, their worst performance is in handling.
- With the following classes of age, this figure is balanced. The medium aged pilots between 30 and 45 have few weak areas.
- Older pilots have severe difficulties in all areas with special emphasis on computer management. Progress here is slow. In handling and approach, not surprisingly, their scores are high. There is a local effect of the age class of pilots of 45-48, which represents the worst results, probably because of several cumulative factors.

As regards the hours flown on their last aircraft

- It is a common hypothesis that the more time spent on the same aircraft, the greater the difficulty in changing aircraft.
- This hypothesis is verified particularly with modern aircraft since the results during the A320 transition course are twice as bad for pilots having spent more than five years on the previous system than for pilots having spend less than five years, whatever the previous system.

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HUMAN FACTORS STUDIES IN AIRBUS TRAINING *(contd.)*

The general effects are not linear (the more the time spent on the previous aircraft, the greater the difficulty). There are some experiences on previous aircraft which facilitate the transition and others which create problems. One year's experience on the previous aircraft is associated with facilitation in the transition course, but two or three years are less advantageous. One can understand this picture in terms of the classic models of learning which state that the first period of the acquisition of expertise consists in associating behaviour with great facility and flexibility in recomposing this behaviour (thus facilitation if the pilot has a change of aircraft). The second period is devoted to organizing and stabilising behaviour towards becoming automatic (changes at this time are very perturbing, thus less profitable). After this stage, basic behaviour is automated and pilots can develop a proper view of what they are doing. This could be considered as the pinnacle of experience because most knowledge is still verbalizable. Finally, beyond this period, the behaviour becomes more and more automated with a progressive simplification of procedures and less consciousness of what it is really done in the cockpit. The final result is to the detriment of easy reconversion.

Of course, the more time spent on the previous system, the more likely the previous system is an old plane. Thus bad results in this case relate both to the long time spent on the previous plane and to the important technological jump between systems. An in-depth analysis of the effect of the technology of the previous plane when transforming to the A320 provides evidence of the considerable advantage of having been trained before on a « glass cockpit » compared with pilots who are experiencing their first training on a « glass cockpit ».

Assessment and cultural factors

A five-level scale is used to assess the various factors and in practical terms extra training sessions are organized if the results are unsatisfactory in any particular area.

There is a very high level of correlation between the results in several areas. As age increases so the familiarity with computerisation, the glass-cockpit environment and English decreases. As regards new technology, a remedial ECAM-MCDU familiarisation on video is available as a pre-course introduction to a new cockpit management philosophy.

If the trainee's English is poor, it is a major handicap affecting all aspects of the learning process for several reasons :

- English is the learning language of the aircraft and its systems ;
- In the new technology, there is more written, as opposed to graphic, information, computers « speak » English ;
- The training situation itself is in English and assumes a constant communication between the trainees and the trainees and the instructor.
- A combined lack of familiarity with both English and computer use slows down the learning process which in turn makes communication more difficult.

Although the trainees' level of English is obviously not the only determinant of success or failure, it is indissociable from several other factors stemming from their cultural background and directly influencing their performance.

The airlines are naturally under financial pressure to limit the duration of their crews' training away from their main base. It is not Airbus Training's vocation to ensure the linguistic and general technical culture of their trainees. Nonetheless the impact of these cultural and linguistic issues on both training and in-service operations cannot be overlooked. ■

MAILBOX

Since the beginning of the Association we have been inviting members to send in their correspondence and set up an exchange of views. We are pleased to be able to open our « Mailbox » at last and hope that very soon our letter box will be overflowing ! It goes without saying that the views expressed here are entirely your own.

PHRASEOLOGY

Dear members,

I teach controllers at the Lyon-Bron airport and to increase the amount of English spoken on the frequency and provide more 'real' practice we've organised « English days ». The pilots are requested to do their RT in English, is they wish. We usually get 50% traffic in English and a rather warm response from users.

However I'm not sure of the right phraseology phrases to be used in some specific - and rather common - circumstances. Can anybody provide suggestions ?

- The light aircraft often request 'PTUs' and 'encadrements' which are both simulated engine failures but not at the same altitude, hence the importance of being able to express the difference ?
- Only one runway is equipped with ILS and when the other runway is used, the IFR pilots still use the localizer and then make 'une ouverture' that is to say join the downwind and circle to land. Is there any particular translation for 'ouverture' ?
- Aircraft crossing the zone sometimes have to fly over the runway at right angles, in French 'couper les axes', is 'crossing the runway centerline' OK ? and 'croissser les axes' 'crossing the extended centerline' ?

Thank you for any suggestions.

Danièle Herbreau, 16, rue du Repos, 69680 Chassieu, France.

SIMILAR CALLSIGNS (C/S)

As you well know, one problem plaguing pilots and controllers alike is that of mix-ups occurring when similar-sounding callsigns are used by aircraft on one frequency.

Being interested in the problem for sometime, I looked for possible contacts in this field when I acquired CompuServe Membership. Well, there I made the acquaintance of Dr. Cushing, who mentioned that you might be interested in this topic. I would be very happy indeed to exchange ideas.

Regarding Callsign Confusion, I'll give you a short rundown on the problem, my opinion on solutions and attach an abstract of a preliminary study that has been done by a student.

By way of introduction, I am a pilot for Lufthansa Airlines, and I am also active with German ALPA/IFALP. I have worked on c/s since 1987, having at the time started a simulation program that shows critical combinations of c/s in airline operations. This program is used by Lufthansa, as well as British Airways (to some extent). The problem is that the flight numbers are used all over the place, and for perfectly legitimate reasons. Therefore, the number of flight numbers that are changed say within a year is limited by the amount of changes that can be handled within the organization. There is a whole bunch of people that are down on your neck if you change too many numbers.

Now, the idea has come up that the usage of US-type pronunciation of c/s might be of help (fortyfive sixtyone ... four five six one). I am not convinced that this would be a big step forward from my pilot's point of view, and ICAO does not like it either. Would you have any specific thoughts on this subject ?

Also, I realized the limitations of changing only numbers within one airline, and tried to interest EUROCONTROL in performing in-depth studies for airlines and ATC alike. Failure in 1990. I continued working on the problem and realized that the introduction of alphanumerics (DLH12W instead of DLH1234) might be of help. This approach has been pioneered by British Airways, with the French ATC developing their own version. IFALPA has had a different alphanumeric system on its books for some 10 years.

Well, in 1992 someone from the French ATC tried again with EUROCONTRO ; a work program was developed, accepted by one committee, and put on a zero funding basis by another. Failure in 1993. OK, but what did I do ? A colleague arrange a contact with Berlin University (Prof. Fellbaum), a student who liked the topic, and a thesis was done on the problem. The work showed that THE PROBLEM requires a lot of work for a good solution. Funding for further work has not been available.

I see the solution to the C/S-problem as requiring a phased approach :

A : 1. As many flight numbers as possible should be substituted by some better, possibly alphanumeric, callsign.

2. A certain percentage of flights will continue to require flight numbers as callsigns due to difficulties with traffic rights or other operational issues.

B : 1. All types of callsign (alphanumeric, flight numbers, or some future type) must be assigned based on a simulation of all planned flights.

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MAILBOX... *(contd.)*

2. Airlines might want to start with their own flight numbers/callsign.

3. A European, but possibly worldwide, Callsign Clearing-house is needed to cover airline-airline similarities.

C : 1. Basic research into Cockpit-Ground Voice Communications is sorely needed. As you know, our equipment is not up to Hi-Fi standard. This critically impairs communications !

2. Basic research into what constitutes an optimum C/S is needed, using a fresh, unrestricted approach.

Appendix

Thomas SCHEIB : Callsign-Confusion in air traffic communications - the problems and possibilities to reduce them

Thesis at the Technical University of Berlin, 1993, 95 pages

The reason for this study was the increasing amount of incidents caused by Callsign confusion in air traffic communications.

A summary of possible influences concerning the problem is given, including the correlation of the different aspects. As a main result the initial stages for solving the problem are formulated.

The various reasons for Callsign confusion can be summed up as follows : technical aspects, linguistic and phonetic aspects, working conditions and workload of communication participants, human factors.

The most decisive contributions are the workload and the human behaviour in stress conditions, the structure of the callsign itself, the pronunciation of the callsign and technical features such as the signal-to-noise ratio and the bandwidth of transmitted frequencies.

To find a solution for the problem it is necessary to carry out further investigations which must contain a data collection of incidents occurring, including all related parameters affecting the situation.

Furthermore, measurements of the noise levels at the working places must be done. With these data it could be possible to determine and reduce the most serious disturbances. Finally, speech intelligibility tests under realistic conditions can be performed and call signs less susceptible for confusion can be developed.

Keywords : Callsign Confusion, Communications, Signal to Noise Ratio, Frequency Bandwidth, Phonetic Aspects (Published in German).

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REVIEW

FATAL WORDS - Communication Clashes and Aircraft Crashes by Steven Cushing, University of Chicago Press, 1994. 176 pages ISBN O-226-12300-5. US $26.95 hardback.

Steven Cushing is associate professor of Computer Science at Boston University where he heads a research team corking on a project called AIR : Aviation Interface Research. AIR is a protype of an « error-resistant » visual interface which in conjunction with the FAA's DATALINK programme, is an attempt to provide ATC controllers and pilots with a more reliable means of standardized communication, featuring menu-guided touch screens whose buttons and icons would enable users to construct, send, receive and reply to messages. The system could even incorporate bilingual screens as well as correct alternative phraseology to avoid monotony. The last chapter and substantial appendix of « Fatal Words » contain a detailed account of this research work which is already well advanced.

Cushing, however, only views AIR as a second best solution for the medium term awaiting the day when an intelligent voice interface, outlined in Chapter 10 and using a voice word recognizer, language filter and intelligent voice output component to process vocabulary, grammar meaning, context and general knowledge will be feasible. Given the present state of the art, this is stall a long, long way down the road.

But why go to so much trouble ? The first eight chapters provide the answer by drawing attention, with concision and relevance, to the shortcomings of current ATC communications and human behavioural factors generally. The ongoing research is an attempt to remedy some of these shortcomings.

This is a slim volume which, if it does not leave the reader with a fallacious impression of beginning to grasp this extremely complex subject, certainly helps him to think more clearly about it. The contents structure of Parts One (Langauge-based communication problems) and Two (Communication problems not based on language) is in itself a case in point providing as it does a finely tuned conceptual apparatus.

It is widely recognized that language has played a part in most of the well-known and less known accidents that have darkened aviation history in the last twenty years and many of which are documented in « Fatal Words ». « Many of the occurrences reviewed here can be attributed to a clash between individual cognitive and social interactive factors of language use. » Within the limited scope of the present article, only a brief attempt can be made to refer to and illustrate some of the sources of error which are so nicely defined.

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WHAT ENGLISH DO CREWS NEED

Alain Sabatier.

Alain Sabatier, formerly an Air Force pilot at AIRBUS TRAINING.

English and Learning

Generally speaking, it is easier for a trainee who is a non-native speaker of English to complete of update his knowledge about a known subject, rather than learn something totally new from scratch. Background and experience play an important part in knowledge acquisition.

Cultural Backgrounds

First impressions provide the instructor very quickly with an idea of how trainees are going to learn and also how they are going to work together. For instance, if the Captain has considerable experience, comes from older generation aircraft and has a poor mastery of English, whereas the first officer has limited experience, few flight hours, but a good level of English and maybe knowledge of computer technology, there could quite possibly be a conflictual training situation. It is therefore the instructor's job to intervene in order to appease the situation and facilitate exchange between the two crew members.

The cultural, personal and political backgrounds of the trainees also play an important role in the nature of the communication inside the cockpit. These factors may inhibit personal expression and only be compounded by a poor grasp of English. There are many cultures where personal problems or ideas are not easily voiced. Similarly during the debreifing session, the instructor has to pay particular attention not to affect people's susceptibilities, self respect or sense of rank by avoiding overt criticism. In other cases close physical contact and body language are essential to create the atmosphere of trust required to build self-confidence.

The instructor must be constantly aware of the situation and how the trainees will respond to a particular form of behaviour. With a two-man crew, the quality of communication between Captain and first officer has become particularly important.

For the instructor too, the language question is not simple. Restricted himself in his handling of the language, he must be able to evaluate and deal with the trainees' difficulties to understand, which are not necessarily the same as his own.

Decision-Making

When it comes to decision-making, the pilot has to « think in English » to some extent, since so much of the information presented to him on the ECAM and MCDU is presented in English. Switching back and forth between the English inputs and his mother-tongue is counter-productive : the decision-making process is slowed down and there is a risk of confusion. However, English is not their mother tongue and the process is far from being problem-free.

The language barrier is very important when training pilots especially because they have to analyse complex situations and make the right decision in a very short time. In aviation, the key word is anticipation. The instructor is constantly faced with flight crews who know their job jut who know their job at a speed which is not suited to the aircraft they are flying.

Learning Environment

During the ground school, on the VACBI (Video and Computer-Based Instruction) course, they are working together learning the aircraft systems in English by viewing and reading two displays and the Training manual. They can work at their own pace, listen to a sequence again and ask questions when they want. Here again the two trainees have to set up a working relationship together based on a vast amount of information presented in English.

Stress and Fatigue

The effect of stress and fatigue is considerable. The pilots spend between four and six weeks at the training center. They are away from home and their families. They have a tight schedule to follow and are soon tired of the training.

Stress and fatigue mean that the trainees very often lose part of their potential to understand and express themselves in English.

Documentation

The language question is also to be kept in mind when preparing training documentation. Documents written by a mother-tongue speaker may be too idiomatic and complex in the syntax used to be easily understandable by everyone. Also, British English could be rejected by American users or vice versa. A certain degree of simplicity and neutrality is essential. It is a commonplace idea that often a simple sketch is more effective than a

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WHAT ENGLISH DO CREWS NEED *(contd.)*

complex explanation. In training the written or spoken message is very often there only to back up graphic information.

English required

The features of English ability needed for training situations are :

- a medium level of conversational English
- ability to paraphrase
- full technical vocabulary
- simple sentence structure.

AIRBUS and BOEING

Although their goals are identical, the training styles at AIRBUS and BOEING are somewhat different. The multinational composition of AIRBUS TRAINING staff means that there is an awareness which leads to more attention being paid to cultural differences among the trainees. The personal nature of the particular instructor-trainee relationship is perhaps also given more emphasis. ■

Multi-national multi-skill training

Saudia's status as a truly international scheduled airline with 10 overseas bases is reflected in the 44 nationalities making up its 3,600 flight attendant workforce.

Newly-recruited cabin staff undergo extensive six-week courses at the airline's training centre in Jeddah under the guidance of 16 instructors representing 11 nationalities.

Equally, with 1,200 Saudi nationals completing the cabin service staff numbers, the airline's English Language Training department plays a significant part in the development programme.

There are now seven on-site instructors in Jeddah providing tailor-made English for Special Purposes courses for Saudia's Front Line Improvement Programme. The aim is to enhance the language skills of employees dealing directly with the public.

Increasingly, instructors are also being sent on-site to meet the more specific needs of individual clients in language skills.

In addition, Saudia's corporate training and development department regularly updates a series of airline-related programmes including sciences, management, finance, administration and micro-computer skills.

PORTRAIT

Peter Harrigan at the Warsaw Seminar

Peter Harrigan has worked as a training specialist in Saudia's Corporate Training & Development Division since 1981. He currently focuses on developing communication and English language skills of cabin crew, staff at flight operations and the newly formed traffic coordination center at King Khdled International Airport in the Saudi capital , Riyadh.

Peter's areas of interest include accelerated learning techniques, language and behaviour under stress as well as individual, group (crew) and organisational behaviour in an airline setting.

Out of work Peter spends his leisure time sailing, diving, desert exploration and tennis.

He is a graduate from the University of Birmingham and has his home on the Isle of Wight.

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THE FUTURE OF CRM

Exploring New Territory

Eddy Racca.

Mr. Racca's address is reproduced in extenso below. We should like to renew our thanks to him for his major contribution to the seminar.

How CRM has been applied in Airbus with a multicultural Approach

« Airbus Industrie has over 100 customers and has therefore to work with this multicultural environment in mind. CRM was first implemented due to the Tristar crash in the Everglades when the American professionals were led to study Human Factors and start up CRM courses. The researchers did not reinvent the wheel; the first CRM courses were derived from management courses. Many companies used the generic acronym CRM or Cockpit Resource Management courses, the M standing for Management from the old management courses. They mainly integrated two researchers' - Black and Mutton's - grid. This grid was made up of two axes highlighting performance or people. At one end you had people who were not at all interested in people or performance and at the other end people interested both in contact with people and performance. On this grid you could find all sorts of behaviour. It was interesting up to a certain point. The course was structured with exercises and tests and when you completed it you could situate yourself on the grid and then make up your mind what to do. Since it was not very convenient, researchers endeavoured to improve it. A second generation CRM course was to be set up and the Airbus course belongs to the second generation. Our intention was not to reinvent the wheel any more than our predecessors. What I first did was to attend a number of CRM courses and finally we elected to work with FSI : Flight Safety International because of its excellence and its adaptability to our needs and also because at that time we were called Aeroformation and FSI was our partner.

We began to prepare our course in July 1990 and by the end of April 1991 it was ready to be used with our trainees. It must be stressed that for CRM or Human Factors courses, even more than for technical courses, recurrent training is mandatory. After a 3, 4, or 5 day course, new behaviour will be observed during up to three months, after which the trainees will lapse into their former behaviour. Needless to say, one day only is insufficient for initial training. It is unfortunate for us that the trainees only stay here for 5 to 6 weeks after which they return to their airlines. We do not have enough time with them to organize long seminars. While the pilots are training they are away from their jobs, which is why the airlines are reluctant to send us these trainees for a longer time. We have therefore only managed to add a one day workshop in which we have integrated a number of Human Factor concepts followed by eight fixed-base or full-flight simulator sessions. We remind the trainees of these concepts or introduce them to other concepts followed by practical exercises, and use video. Thus the name we gave our course which is called AIM : *Aircrew Integrated Management* because it is fully integrated to the trainees' session here. Of course our "aim" during this course is to improve *safety*.

At the outset, this training was provided for A320 pilots on their transition courses only, since it was our newest aircraft and our most up-to-date course. There were few people working on it and so they could only deal with the A320 course. They were called *facilitators* rather than teachers. But today they have increased in number and AIM is provided for all Airbus training, no matter what the type of aircraft.

The content of the second generation CRM courses is as follows.

- The objective derives from the analyses of real accident case studies in order to prevent accidents where ineffective crew functioning is a major contributor (70% of the cases). It must be stressed that an accident is NEVER due to one factor only, but to an accumulation of causes.

  Safety will be improved through crew synergy.

- The subjects addressed are :

  - ***individual attitudes***, a team being made up of individuals who should have the right attitude in order to work together
  - ***command and leadership*** which we demonstrate as two very different concepts:
  - ***command*** is related to the captain who is the chief or boss on board and is responsible for the flight in all circumstances.
  - ***leadership*** is a notion related to a function (under the captain's responsibility). The first officer, flight engineer or purser may be the leaders for certain tasks : i.e. as when the captain gives the leadership to the first officer to file the flight plan or go to the weather office.
  - ***communication*** is an essential point in CRM on which we spend a lot of time.

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Accident studies reveal that in 95% to 98% of cases, communication was involved.

1) In the Everglades Tristar crash the ATC said «What are you doing ? » instead of saying : «You are at 900 feet.»

2) Another case in point is the Avianca 707 crash close to New York City in which language and communication were determining factors, not only between the aircraft and the ground, but also in the cockpit. The captain spoke little English and the first officer was doing the radio traffic. In their native language the captain requested that the first officer declare an emergency several times and the latter never complied. Therefore people on the ground were not at all aware of the gravity of the situation.

3) The worst of all accidents was the crash that occurred between two B 747s in Tenerife in which 550 people died and it was purely due to a problem of communication existing between the tower and the airplanes and in the KLM cockpit as well.

- ***situational awareness*** is linked to what a pilot learns in his first flight when his monitor tells him he has to be ahead of and never behind his airplane. Each individual crew member must be aware of where he is, but so must the crew as an entity.
- ***error chain*** is a concept showing that an accident never occurs suddenly, but is the result of a chain. We have developed 11 clues that show you are involved in an error chain. If you are trained to detect them then you can learn to correct them. An illustration of that, is the MD 80 crash at take-off at Detroit International Airport, killing everybody on board, due to the fact they took off without flaps and slats. At the previous flight, the crew had missed the gate and were obliged to make a 180° to go to the right gate. They were also supposed to go on taxiway C 3 and missed it, taking C 4. In itself this was not necessarily catastrophic, and has happened to many pilots. But it reveals the pilot was not fully at his job and was a clue showing he should have been more focused on his job.
- **decision making** is crucial to a pilot's job. When working, a pilot must make decisions and change as in the case of a closed destination airport, when it is necessary to divert or there is a need to change runways.
- **stress management** is very important for professional pilots, since stress is related to so many factors all along the flight. »

The METHODS used

« Seven years ago when Claire Pélegrin and myself began in the area of Human Factors we were very careful to avoid using such words as psychology, which pilots rejected.

- we simplified scientific models and references
- we related to the pilots through their jobs and this was the purpose of the video shown yesterday, where we showed them other pilots working in their normal environment setting them as models of behaviour.
- the role play devised was non job-related, but created by the scientists who devised the courses and not aviation professionals. Therefore, there was a separation between technical and Human Factor skills.

We were the first manufacturer to introduce a Human Factors course. Nowadays, all the airlines claim to have such courses. But in 5 to 10 years nobody will talk about them, as they will be integrated into general training and added to the teaching of manual skills (how to fly), the systems, navigation, weather, etc.). If first generation training was very theoretical, the second generation has been committed, on the contrary, to giving practical rules. Indeed, we give practical rules for good communication, good listening , good feedback and obviously the study of real accident cases which are very powerful. We show them that most accidents occur with competent, experienced pilots who are well noted by their airlines and highly respected, but not with beginners. To quote the Tenerife crash once again, the reputable chief captain of the KLM B747 who was highly respected in the aeronautical world, was the main cause of the crash. This is a pedagogic illustration that accidents can happen to EVERYBODY. We need such powerful illustrations when dealing with 55 year old captains who feel that having flown 15, 000 hours they cannot be told anything. »

Experience with our CRM Training

« We have two training centers : one in Toulouse and one in Miami. We qualify the training at the end of the courses thanks to Helmreich's CMAQ (Cockpit Management Attitude Questionnaires) and self-evaluation feedback. The Toulouse center uses European instructors and receives trainees from all over the world. The Miami one uses American instructors exclusively. In comparing the CMAQ between Toulouse and Miami, the ranking of the exercises, the subjects and concepts of the lectures are the same. However if we look more closely at the marks scored given from 1 to 5, we notice that they are always significantly higher in Miami than in Toulouse though ALL the instructors were trained initially for the same course, here in Toulouse. The ratio is 3:1 in Toulouse for 4:1 in Miami. As Helmreich claims: "CRM was developed in the US by US researchers and was designed to fit US culture norms." At all seminars on the topic, even in the US, everybody tends to agree that Second Generation CRM was too highly influenced by American culture and so if we want CRM to be accepted worldwide we must adapt it to different cultures.»

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The glass cockpit

« This new environment changed a number of essential things for pilots, decreasing the crew over the years from five to four to three to only two crew members.

Also, many clues have disappeared. In the old cockpit when the other pilot moved his hand toward an instrument each one being devoted to one task you knew what he was about to do : for example, one could tell if he was about to change the VHF, or set the speed. Now almost everything is done by the FCU (the Flight Control Unit) or the FMS. So if your colleague's hand goes toward the FCU you cannot tell what he is doing unless he says so in so many words. Even if you look at the instruments you cannot know what is happening. There are also the fixed throttles and the small sidesticks and here again a number of visual clues have disappeared. It therefore becomes critically important for a pilot to tell his colleague anything he does in the cockpit. There is also the fact that only 2 two people are there to manage the flight, meaning that it becomes more essential than in a 3-man cockpit to have excellent task sharing and good work load management.

• ***Conflict*** between two people is very different - and not necessarily better or worse - than when there are three people, and this must be taken into account.

• ***Communication*** between the pilots can be done through the automatic systems : for example, if I change the flight plan I do so through the FMS; I change my speed etc. It is important to be aware that the kind of communication we see here is on a man-man, man-machine, machine-man but also man-machine-man level. This is something that struck us and all the trainers on similar courses elsewhere.

We have gone a long way in seven years. At the outset, there were two to three seminars on Human Factors gathering no more than 100 participants. Today we must carefully choose which one to attend, given the plethora. Many of the events are organized by major institutions all over the world, such as ICAO, IATA, Flight Safety, etc. and attended by anywhere between 200 and 300 people, in spite of the recession. »

The Evolution of CRM

« As mentioned, a new generation of CRM courses has had to be designed to suit the new generation of automated aircraft. In addition to their technical knowledge, the trainees are faced with the need to learn a new type of behaviour related to these planes. What has been increasingly shown, is that safety issues are not only related to pilots but to every part of the aeronautical system. The focus is now shifting from the pilots in the cockpit to the entire crew. Although it is the pilots in command who crash the plane, they are not the only people involved. So today the trend is to extend responsibility to the entire crew, that is cockpit crew as well as cabin crew, ATC and maintenance people.

A case in point, highlighting the role of cabin attendants, is the British Midlands B737 crash in Kegworth, near London. They experienced a problem with their left engine : the burning of the seals, with much vibration and tremendous flames issuing from the left engine. Due to the technical design of the aircraft, the crew made a mistake and instead of stopping the left engine they stopped the right one. Unfortunately, all the seals had been burnt and the engine began to stall with vibrations, the crew believed they had done what was necessary and the captain made a public address announcement, saying : «Ladies and Gentlemen we have experienced a problem on the right engine. Everything is under control. We are now about to land.» Three flight attendants and some passengers had seen big flames issuing from the left engine. Yet nobody phoned or went to see the captain to tell him he said the right engine when they witnessed it was the left ! When they attempted to land, being a bit short they added power to the damaged engine, with reduced power it had continued to run, but when the crew ordered full power the engine stopped. As the good engine was stopped the aircraft crashed. This shows what the cabin attendants might have done.

At the other end of the spectrum with the DC10 crash in Sioux City the cabin attendants told what they had seen on the wings and this helped the cockpit crew.

For ATC and maintenance there are numerous examples that may be quoted. One involving maintenance is the case of the British captain on a BAC 1-11 who, due to the replacement of a windshield with the wrong size screws, ended his flight hanging out of the cockpit.

Today, even companies and corporations are part of the CRM loop. Indeed, the crew follow company regulations, policies and cultures. The manufacturer can be responsible for wrong design or training. Therefore we may claim that everybody at every level is involved. James Reason of the University of Manchester has researched on Human Error and written an extremely well documented book on the topic. His theory is that an accident does not occur in a vacuum. Everyone in a company from top to middle management, down to the workers has their share of responsibility. He has developed a model showing that at each stage and any time people see failures these are corrected, but he has also pointed out that latent errors which were not noticed exist and will surface at one point or another, given the right conditions. In spite of safeguards, these latent errors await the opportunity to pop up at some other point, leading to the accident. This model gave us the notion of systemic responsibility.

This is a new view. Indeed it was once believed, that if one could spot and classify all the different types of pilot errors, they could be suppressed. In fact we now know this is impossible. The only thing that is possible is to classify and analyze the types of errors young pilots, old pilots, expert pilots make and determine a way to train them to be aware of these kinds of error. Mentalities have thus changed. At first there was hope it

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might be possible to suppress error. However, that is impossible given it is part of human nature. Reason claims human nature is like a coin with 2 sides to it : one fantastic and capable of creating, with the gift of imagination, of innovation; the other capable of making errors. New concepts underline that fact and how we should cope with human error. Our courses, as well as aircraft design, take this factor into account. Previously, the idea was to make a design for an environment where it was impossible to make errors. People were trained to use that design properly. Now the philosophy is different , for we know that people will always make errors. That is why we are trying to design systems tolerant of error and if possible, pointing to the errors made. Every time you misuse the system, it will tell you so. This design concept is very different. »

Third Generation CRM : The Pro-Active Versus the Re-Active Approach

« We are about to sign a contract with a group called *Dédale*. The people belonging to the group are from a variety of professional backgrounds i.e. doctors, psychologists, researchers, airline pilots, video film makers at the cockpit level, etc... We began to work with *Dédale* that has devised an Air France ATR-CRM and a Human Factors course in compliance with ICAO's demands. We intend to implement the course we are jointly designing, by the middle of 1996, but it is a year long process. It will be addressed not only to pilots, no matter what aircraft they fly, but to cabin crew members and maintenance people. For practical reasons, the companies that send these professionals to be trained cannot send them all at once. Instead, we get the maintenance people first, then the pilots and lastly the cabin crew instructors who train their colleagues later. It would be a good idea to organize some half-day sessions grouping all of the professionals. Unfortunately, that cannot be done. So, what can be done at the airline's training center, cannot be done at the manufacturers' headquarters. We have some common core modules that will be taught to all the categories and we will clearly specify that they are addressed to *ALL*. But we will also design tailored courses either with video materials specifically for pilots, cabin attendants or maintenance people.

The objective will be to improve the overall performance of the system and not just the crew members' performance. So in fact, we will be looking at the basic unit of the crew-aircraft system, the technical and cabin crew, to which we may add ATC, etc... We may say that if second generation CRM had a *RE - ACTIVE* approach we are now trying to have a *PRO-ACTIVE* approach to safety in order to enhance the functioning of the system. Not only will we be giving CRM courses to our trainees, but we will soon be giving all Airbus Industrie personnel a Human Factors course. Starting off with the Dédale Human Factors course, we will add specific modules addressed either to the design office, the flight test, the sales department or the administration department, focusing accordingly on certain aspects of Human Factors. The general objective is to improve the entire system. The difference between *RE-ACTIVE* and *PRO-ACTIVE* is reflected in the analysis of past accidents on the Human Factors level. Before, everybody would analyze the accident, noting that the accident was due to a lack of communication, for example. So, the right thing to do was to teach people to learn how to better communicate better. However people always tried to know how the accident had occurred after the accident and thus reacted accordingly. Today the accent is focused on trying to understand human behaviour better and to understand beforehand what might be the weak points within the system that could possibly lead to an accident.

We may now introduce a generic model of human performance. The model will cover cockpit interaction, attitudes, leadership, communication, cooperation and mental representation. The latter point is highly important. Indeed, in the past, pilots had a mental representation from the maps and charts they looked at prior to their flights. Today they have a representation on their ECAM and EFIS. The maps and so forth are very clear, which is good, but people tend to rely on that and forget to visualize the model in their mind. So if there is a problem on the screen, they are lost. It is extremely important to have a clear mental representation. Also, as a pilot, it is very important to realize that what you see is a representation and not reality. A representation of reality is not reality !

The workload and confidence are also related to *automation*. Very schematically, one can have two very extreme attitudes toward automation. On one hand, one may be reluctant, and that of course is negative, since automation has been tested, proved, etc.. and can be relied on, as being safe. The other attitude is one of overconfidence and finally complacency. Some tend to put everything into the hands of automation. We always point out to pilots that they must not be the passenger in the cockpit. "You are the pilot and in charge of the automatic systems!", we stress. We tell them not to be over reliant and over confident with automation, that automation is there to help them but that they are the boss and have to monitor it.

In the realm of decision making, vigilance, stress and *fatigue* are factors. The latter point is of utmost importance for pilots. At first, research dealt with long haul pilots working on 10, 12 and now 14 hour flights for which, even in the case of reinforced crews, conditions of fatigue are extreme. Indeed, in spite of a 2 to 3 hour periods of sleep, due to the noise and dry air the pilot cannot really relax. Yet with short haul flights as well, conditions are far from ideal. Such is the case at Air Inter the French domestic airline, where you have pilots flying in one day from Paris to Nimes and back and then from Paris to Toulouse and back. Each time they are at turnaround, people come along to inquire about a number of problems such as refueling, catering or baggage handling. Therefore they too are under

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very stressful conditions. We have taken these into account in the Human Factors field. A joint document is about to be published by Airbus and the DGAC (the French Civil Aviation Authorities) giving information about fatigue and some guidelines to pilots in order to cope with this factor. For example, for a long haul flight on which there is a reinforced crew we suggest that 2 to 3 days before the flight a short meeting be organized, enabling the crew to check which people go to bed late or get up early in order to organize shifts accordingly. Another factor, according to the James Reason model, is reliability.

Finally the *cultural factor* is taken into account based on the Hofstedt model (as we saw in Claire Pélegrin's paper). Not only has Neil Johnston, a pilot at Aer Lingus with a PhD, largely contributed to this study, but people from the Middle East who are confronted with the multi-cultural problem as well. In this field we try to show people how human behaviour works and to help them find their own solution. Our illustration is the example of planting a seed in order to grow a tree, for which you need to dig a hole with a spade. We insist on the fact that soil varies worldwide as well as tools and techniques. Our attitude in 3rd generation CRM is to tell trainees that to grow a tree they need a seed but that it is up to them to choose their tools and the way to water in relation to their own soil and environment.

As Peter Harrigan mentioned, we too feel complexity is increasing as we go from Cockpit Resource Management to Crew Resource Management, Company Resource Management and now Corporation Resource Management. In the first case only the pilots are dealt with. With Crew Resource Management the cabin attendants, ATC and maintenance people are involved as well. But now everybody is concerned from top management, including the manufacturers and airline people, to the airworthiness authorities. Approaches vis à vis management are shifting. For example, one way of dealing with airline management would be to insist on their responsibility in the field of safety. But that is a totally wrong approach, which they would not understand. So our discourse has changed and we tell managers that their job is to make sure their company will be making money (this of course will guarantee jobs). For that, it is necessary to have customers, passengers, and in order to do so, safety is essential.

The new orientation of third generation CRM courses is very participative with discussions to develop understanding and knowledge of Human Factors. Appropriate knowledge can be taught through clear simplified scientific models, adapted to all categories of trainees. Naturally, the trainees will discover the concepts through examples drawn from their daily professional reality. We are using an integrated approach, several concepts being included in all the fields of technical training, checks, incidents, investigations and so on. Up to now, pilots came and were separately checked annually in the simulator and you could sometimes see a captain succeed whereas the pilot from the same crew failed the annual check. Today we make it mandatory for the crew to succeed or fail the check flight as a crew, because that is the way they work. »

Questions and Comments

« Q: You stated that between the Miami and Toulouse training centers the Americans rated training higher. What do you attribute that to ? »

« A: To a number of factors. There is a cultural element and grading is higher in the US. Another point worth noting is that our facilitators in Toulouse are from a variety of cultural backgrounds (French, German, Italian...) and teach people of a wide range of cultures. As you see, my English as a French speaker is not like a German, Italian or Tunisian person's. Also our trainees, the pilots, are used to technical English and not to psychological English. As you noted a minute ago, I needed your help to find some of the right words to tell you about the example of the tree. On the other hand, as French speakers, when we are training at Air France, Air Inter or Tunis Air we can easily exchange subtle ideas and concepts with our trainees. In Miami our facilatators are American. Also, at the end of some interesting sessions, we are sometimes surprised by the poor ranking on the final assessment questionnaires, ranging from not useful to highly useful, whilst we found everything highly relevant to our trainees' needs. Our course is in a constant stage of renewal, and if, for example, trainees rank some exercises at a low level we analyze the reasons and modify accordingly. »

« Q: Have you tried to get feedback from your trainees once they are back on the job ? »

« A: It is not an easy task, given a number of factors such as confidentiality, unions, etc. However, in spite of the difficulty of evaluating them on the job, some airlines have noted a change in their work relationship, for example the pilots feel more confident to express their concerns, more willing to give their captain feedback and captains are more inclined to facilitate communication, to encourage the first officer to let him know if he has any problems. Through this better communication, they reach a better level of task sharing. Another point that is worth noting is that for some airlines who buy planes and training in a single package, only some of the crew members are trained with us; the others are trained later within the airline but without CRM. We have had requests from them to provide the other people, with a Human factors course. In some companies the crew members, unfamiliar with the training, have noted outstanding differences in work attitudes and want to learn as well. »

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THE FUTURE OF CRM *(contd.)*

« Q: Has CRM improved attitudes in crew members in glass cockpits who given the overload of numerous warning lights and signals tend to disregard them? »

« A: This is often still a real problem and the engineers will have to attempt to differentiate the warning signals. If there are only red flashing lights and repetitive chimes the pilots will jump to cancel the lights thereby canceling the stress, without providing a solution. I have seen the autopilot being disconnected causing the plane to dive and the pilots with a questioning glance turn to me as their instructor for help. Behind them I would smile and tell them to simply take their controls smoothly. They would jump to do so. A Russian pilot from an old generation aircraft told me they had a warning for autopilot disconnected which was a charming woman's voice repeating "Autopilot", and it worked. It is true that the problem of warnings is an old story. Until recently the number of instruments and warnings was on the rise, moving from Junker 52, to DC3 B 747 and Concorde, but now it is decreasing. Nonetheless, it is very difficult to choose what is most important to warn about and how to do so. When I was working in the Flight Test Center I was in charge of airworthiness for specific aircraft and it really is a complex problem we have always looked at. »

« Q: I have heard the DGAC is about to make CRM mandatory in France ? »

« A: It will be the JAR at the European level who will make CRM compulsory for all of Europe. All the state airworthiness authorities are going to impose some Human Factors training in the future. CRM will be mandatory for all airlines and Human Factors courses for licences. Everybody will have to have a certificate. In ICAO's annex #1 it will be compulsory worldwide to have a well-defined Human Factors course with a related final exam for any professional pilot licence, no matter what the level. Today, in England, the authorities have extended this to private pilots. In 1994 over 2,000 English private pilots passed the Human Factors exam. The first company in the world to give CRM courses was United Airlines in the 1970s because they had the worst rate of accidents due to safety factors in the States. Passengers started flying with other airlines and ultimately this led management to take action. » ■

REVIEW *(contd.)*

Ambiguity is a major cause of poor communication, but ambiguity is multi-faceted. It may stem from divergent personal interpretations, often the result of sloppy phraseology or linguistic code switching :

> « We are now at take-off » (Tenerife 27 March 1977)
>
> « Just go ahead and hold » (John Wayne Orange County Airport 17 February 1981).

Either the inherent homophony of the English language used, again combined with non-standard phraseology:

> « Climb two five zero » (to / two / too)

or the perception of intonation :

> « Back - on the power »
>
> « Back on - the power ».

Speech acts themselves may contain ambiguity :

> « Traffic at ten o'clock, three miles, level at 6,000, to pass under you. »

What the pilot construed as an instruction to descent to 6,000 feet was a report on the other traffic.

Reference may be uncertain in communication and this uncertainty compounded by anticipation.

> « Eastern ah, four oh one how are things coming along out there ? » (Miami 29 December 1972).

Courses may be confused with flight levels, airports with beacons bearing the same name.

- Aircraft heading 300 at FL270.
- Controller gives aircraft a vector to 310.
- First officer acknowledges310 but climbs to it instead of turning to it.
- Captain, distracted at first, points out his mistake.

Faulty inferences, facilitated by the different environments and mind sets of controller and pilot, may be another source of error.

« We were under the assumption we were cleared because we were told we were number one for the approach and not told to hold or expect any delay. »

« I can give you 290 but you will have to negotiate for higher » was misconstrued as a clearance whereas it was delivered as a statement of possibility.

Transmission problems such as the time delay on pressing the mike button due to squelch control or intermittent interference can obliterate key words and mar communication. Full readbacks are often lacking and so fail to provide radiotelephony with the foolproofing it requires. Linguistic and technical inadequacy may be aggravated by human factors such as distracted attention, fatigue, impatience, obstinacy or crew conflict.

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LINGUISTIC SECURITY IN THE SYNTACTIC STRUCTURES OF AIR TRAFFIC CONTROL ENGLISH

(Part Two)

Denis Philips

Denis Philips lecturer in English at the Université des Antilles - Guyane, Martinique, French West Indies and also works at the Université de Toulouse Le Mirail. He is author of « L'Anglais de la circulation Aérienne », ENAC 1989. We conclude his article started in the previous issue of the Newsletter.

6. Sentence-level Transformations

The notion of linguistic security may be informally defined as the degree of ambiguity pertaining to an utterance, whether of a syntactic or semantic kind. Total linguistic security would equate with degree 0 : but, as will be seen, this is not always achieved by the subgrammar's rules. In order to highlight the relationship between mood and illocutionary acts in the phraseology, an initial distinction will be made between sentence-level and phrase-level transformations.

The former are those which establish the mood, logic or voice of an utterance (declarative, interrogative, imperative, negative, active, passive) : the latter, sometimes referred to as processes, (such as deletion, adjunction, fronting, permutation, nominalisation, etc.), are also found in sentence-level transformations. However, considered independently, they can be shown to account for two other major features of the phraseology subgrammar : ellipsis and surface-structure mobility. The four types of sentence-level transformation found in the phraseology (in relation to the unmarked positive declarative form in the active voice) are as follows :

- imperative (42.5% of all utterances)
- passive (8.1%)
- interrogative (1.8%)
- negative (1.7%).

The preponderance of imperative utterances, all of which are controller-sourced, is a reflection of the major function of the controller, which is to give instructions to the pilot. In the phraseology, the use of the imperative is closely, but not exclusively, related to scenarios involving changes (of heading, level, etc.) or movement (crossing, passing, etc.) : e.g. :

« CONTINUE PRESENT HEADING »
« TAXI TO HOLDING POINT »
« MAKE STRAIGHT-IN APPROACH »

The imperative T-rule generates the same terminal string in the phraseology as in natural English. Moreover, the imperative replaces virtually all other syntactic structures used in natural English to convey the illocutionary forces involved in inciting another person to perform an action, notably modal and interrogative formulations :

*« I WOULD LIKE YOU TO CONTINUE... »

*« WOULD YOU MIND TAXIING... ? », etc.

This latter type of formulation, involving expressions conveying contrasts in mood (degrees of certainty, possibility, necessity, futurity, obligation, etc.) as well as intentions and attitudes, is clearly incompatible with an aeronautical environment where precise, concise instructions are the rule.

As for the passive transformation, the terminal string found in natural English never materialises in the phraseology, due to various T-rule deletions. Indeed, passive formulations have a very specific distribution, in that they are only found in a small number of aeronautical contexts : for example :

i . « (NO) RADAR CONTACT HAS BEEN ESTABLISHED »
ii . « (NOT) IDENTIFIED »
iii. « (RE)CLEARED »

corresponding to the following natural utterances:

i. « (NO) RADAR CONTACT HAS BEEN ESTABLISHED »
ii. « YOU HAVE (NOT) BEEN IDENTIFIED »
iii. «YOU ARE (RE)CLEARED ».

This process of reduction reminds us of certain computer coding techniques used in signal processing, such as data compression, where only part of any given message is actually transmitted, but a part sufficient to allow the whole message to be restored by the receiver with complete integrity. Here, only the logico-semantic part of the message is transmitted, as the aspecto-temporal data can be recovered by the pilot through his extralinguistic knowledge of each context.

As regards subject pronoun deletion, this is not unknown in natural English (e.g. : « Went back to school today. »). However, it is systematic in passivised declarative utterances in the phraseology, as the two parties (controller and pilot) are pre-identified and require not further overt determination.

Finally, we shall turn our attention to interrogative and negative transformations, their frequency in the phraseology being considerably lower than that of passive and imperative transformations. For example :

* Agrammatical (in terms of the phraseology subgrammar).

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LINGUISTIC SECURITY IN THE SYNTACTIC STRUCTURES OF AIR TRAFFIC CONTROL ENGLISH *(contd.)*

(Interrogative) « CAN YOU CLIMB... ? »
« DO YOU WANT VECTORS ? »
« ARE YOU READY... ? »
(Negative) « APPROACH NOT AVAILABLE »
« DO NOT ACKNOWLEDGE FURTHER TRANSMISSIONS »
« I DON'T READ YOU ».

The small number of interrogative and negative formulations clearly indicates the intention of the phraseology designers (an ICAO air navigation committee) to keep non-declarative and non-positive utterances to the absolute minimum, due to the special requirements of the aeronautical environment.

The interrogative transformation appears only rarely in the phraseology, and the T-rules employed generate the same terminal string as in natural English (no deletion of the auxiliary phrase constituents or of the NP1). More interestingly the interrogative formulations in the « Climb or Descent with Visual Separation » section contain the only occurrence (excepting WILL and one example of SHOULD elsewhere) of a modal auxiliary in the whole corpus ;

« CANYOU CLIMB (OR DESCEND) AND MAINTAIN OWN VISUAL SEPARATION ? »

« CAN YOU MAINTAIN OWN VISUAL SEPARATION DURING CLIMB (OR DESCENT) ? »

This almost total absence concerns the category of modal auxiliary, and not the notion of modalisation, vehicled by other constituents, notably adverbial phrases. In the above cases, the controller must ascertain, prior to issuing an instruction, that the pilot is actually in a position to carry out the instruction (in view of the aircraft type, meteorological conditions, etc.). Hence the value of the modal is not one of politeness, but one of capacity (« CAN » = « ABLE TO »).

This kink of scenario is however, very infrequent : the typical « algorithm » involves the issuing of an instruction which may require a response from the pilot, which may in turn entail the controller rephrasing his original instruction.

Turning to negative utterances, one observes that in those containing a copula, or link verb, the latter is systematically deleted (e.g. « SECONDARY POWER SUPPLY NOT AVAILABLE »). This tends to suggest that in English, as in other major world languages such as Arabic, this type of predicator does not need to be materialised to establish the subject-complement relationship, since phenomena such as juxtaposition and linearity suffice to perform the same function. Furthermore, link verbs have little independent meaning, and can be quickly and easily restored by the receiver.

In conclusion, the sentence-level transformations found in the phraseology have two essential characteristics : firstly the high frequency of imperatives in relation to other formulations, and secondly the specific T-rule deletions in relation to natural English. The systematic nature of these deletions clearly demonstrates that the phraseological utterances are governed by syntactic rules whose function is to restrict the linguistic content to the logico-semantic data, the onus being on the receiver to recover the suppressed morpho-syntactic constituents. The latter are of three main types :

- auxiliary
- relational (functors other than determiners)
- determinative (determiners).

7. Phrase-level Transformations

Let us now turn our attention to what we have called « phrase-level » transformations (deletion, adjunction, fronting, permutation, nominalisation, etc.). Several of these do, or course, occur in the sentence-level transformations previously addressed. But the sentence-level/phrase-level distinction is useful in that it allows us to highlight the relationship between mood and illocutionary force in the phraseology. This is vital to a proper understanding of the way in which the phraseology functions, with its specific distribution of statements, questions and commands, and its extralinguistic context, where the sources are pre-identified and the aeronautical scenarios codified.

The above distribution also helps us to demonstrate the particular use made of transformational processes as compared with natural English, and thereby to create a syntactic differential.

The latter is an elegant and economical approach insofar as it avoids us having to posit modified deep-structure T-rules to account for the phraseology subgrammar. In consequence, the phrase-level transformations are considered as being « reapplied » to the terminal strings corresponding to each natural English utterance. The first and most obvious statement that can be made about Table 2 is that the syntactic modifications in the phraseology concern each constituent of the simple sentence : the noun group, the verb group and adverbials. We shall first study those relating to the noun group.

A manor feature of the phraseology subgrammar is that the determiner is systematically deleted, whatever the function of the noun group in which it is found (subject, object, prepositional complement, etc.), except for one or two inconsistencies which we shall mention later. An important point to note is that the determiner is almost always a definite article or a possessive : this helps to explain why deletion is possible : the noun is already determined in part by the extralinguistic context, and further intralinguistic determination is therefore redundant. Here are some examples of determiner deletion :

« WHEELS APPEAR UP »
« RESUME OWN NAVIGATION »

Corresponding natural utterances :

« YOUR WHEELS APPEAR (TO BE) UP »
« RESUME YOUR OWN NAVIGATION »

Determiner deletion is often accompanied by link-verb deletion or BE (Aux) deletion in passive utterances, and re-

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LINGUISTIC SECURITY IN THE SYNTACTIC STRUCTURES OF AIR TRAFFIC CONTROL ENGLISH *(contd.)*

sults in the head noun occurring at the beginning of the utterance. For example :

« SPEED AT OWN DISCRETION »
« REPLY NOT RECEIVED »

Corresponding natural utterances :

« YOUR SPEED IS AT YOUR DISCRETION »
« YOUR REPLY HAS NOT BEEN RECEIVED ».

This modification may also be found in prepositional phrases such as :

« CLEARED TOUCH AND GO »
« REPORT HOLDING POINT »

Corresponding natural utterances :

« YOU ARE CLEARED FOR A TOUCH AND GO »
« REPORT AT YOUR HOLDING POINT »

where there is a double deletion (preposition of purpose, position, etc. + determiner). The second utterance (« REPORT HOLDING POINT ») pinpoints the limits of multiple deletion, showing how the latter can result in ambiguity in certain contexts. Here, two interpretations are possible :

(1) What is your holding point ?
(2) Report when at your holding point.

It is only the pilot's knowledge of the aeronautical context which allows him to select the correct interpretation (in this case n° 2). In the noun group, subject pronouns are also systematically deleted in declarative utterances when they refer to pilot or controller :

« WILL SHORTLY LOSE RADAR CONTACT »
*« REQUEST A VMC CLIMB »
*« AM GIVING WAY TO... »

Corresponding natural utterances :

« YOU WILL SHORTLY LOSE RADAR CONTACT »
*« I REQUEST A VMC CLIMB »
*« I AM GIVING WAY TO... »

Subject pronoun deletion, accompanied by auxiliary deletion in progressive structures, is widely attested in the morphology of natural languages (Spanish, Arabic, etc.) and special-purpose languages (e.g. telex English), though often with differing constraints.

It is particularly appropriate to the phraseology, due to the simple verb inflection patterns in English, but above all to pre-identification of the sources in a pilot<>controller dialogue. Other noun group modifications such as -ING deletion and verb nominalisation deserve particular attention, as they serve to highlight the linguistic « philosophy » of the phraseology :

1) * « REQUEST DETAILED TAXI INSTRUCTIONS »
2) « STOP CHARLIE SQUAWK »

Corresponding natural utterances :

1) *« I REQUEST DETAILED TAXIING INSTRUCTIONS »
2) « STOP SQUAWKING CHARLIE »

N.B. : SQUAWK = Set the transponder mode and code as instructed (data interrogation systems)

CHARLIE = Altitude reporting feature (Secondary Surveillance Radar).

In 1) above, there is structural simplification of a participial form used adjectivally, by deletion of the -ING suffix, morpheme. In 2), the -ING deletion occurs in a complex phrase structure with concomitant nominalisation of the natural English verb form, again concentrating the semantic content into a more compact syntactic structure. The above examples, and others already mentioned (e.g. « START UP AT (time) » < « YOUR START-UP IS AT (time)), tend to suggest that the distinction between the function of the noun group and verb group is, in the phraseology, less fundamental than in natural English.

Nominalisation is of course one step on the road to lexicalisation (converting strings of morphemes into autonomous lexical units), which is in turn a step towards « semantisation », i.e. concentrating meaning into lexical units, rather than spreading it over morpho-syntactic boundaries. The process of semantisation is particularly appropriate to the phraseology, the object of which is to create the simplest and most transparent interface between the intra- and extralinguistic planes i.e. between the code and the reference.

We shall turn now to an examination of the verb group, beginning with its auxiliary constituents. In the phraseological utterances containing auxiliaries, (HAVE + -EN, BE + -ING, BE + -EN), the latter are systematically deleted. For example :

(-ING) * « LEAVING FREQUENCY »
* « CROSSING RUNWAY »
« CLOSING FROM LEFT ».

Corresponding natural utterances :

(-ING) * «I AM LEAVING THE FREQUENCY »
* «I AM CROSSING THE RUNWAY »
«YOU ARE CLOSING FROM THE LEFT »

(-EN) « SQUAWK REPLY NOT RECEIVED »
« CLEARD... »
« START-UP APPROVED ».

Corresponding natural utterances :

(-EN) « YOUR SQUAWK REPLY HAS NOT BEEN RECEIVED »
« YOU ARE CLEARED... »
« YOUR START-UP IS APPROVED ».

* indicates a pilot-sourced message

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LINGUISTIC SECURITY IN THE SYNTACTIC STRUCTURES OF AIR TRAFFIC CONTROL ENGLISH *(contd.)*

In all cases, there is associated subject-pronoun deletion, as mentioned previously. The auxiliary suffixed -ING and -EN remain the only trace of aspecto-temporal marking in the above utterances, hence many interpretations are possible : I AM / WILL BE / WILL HAVE BEEN, etc. Only the pilot's intimate knowledge of each particular aeronautical context can allow him to choose the correct interpretation.

Other modifications found in the verb group are as follows :

a) object-pronoun deletion, e.g. :

« IF YOU READ » < « IF YOU READ ME »

Here, subject-pronoun deletion is blocked by the conditional, whilst the object pronoun refers to a pre-identified source.

b) link-verb deletion, e.g. :

« SPEED AT OWN DISCRETION » < « YOUR SPEED IS AT YOUR OWN DISCRETION »

Link-verb deletion is virtually systematic in the phraseology : however, it can be blocked by adjective complements :

« HEADING IS GOOD » < « YOUR HEADING IS GOOD »

c) verb-group deletion, e.g. :

« (NO) RADAR CONTACT » < « (NO) RADAR CONTACT HAS BEEN ESTABLISHED »

Even if another corresponding natural utterance were to be posited (« I HAVE (NO) RADAR CONTACT », for instance), there would still occur a thematisation process involving deletion of the verb group.

d) preposition deletion in prepositional verbs, e.g. :

« DO YOU AGREE DEPARTURE FROM...? » < « DO YOU AGREE TO A DEPARTURE FROM...?».

Again, subject-pronoun deletion is blocked, this time by the interrogative transformation. As we shall see, preposition deletion is very common in the phraseology, particularly in adverbials.

The verb-group deletions listed above serve to eliminate those morpho-syntactic constituents which are not essential to recovery of the semantic content of the message, thereby focusing the pilot's attention rapidly on the controller's meaning.

As regards adverbials, these are modified in the phraseology by various minor (phrase-level) transformations:

a) deletion of prepositions of direction, place, purpose and time, e.g. :

« CLIMB (level) » < « CLIMB TO (level) »

« TRAFIC (number) O'CLOCK » < « YOU HAVE TRAFIC AT (number) O'CLOCK »

« LINE UP RUNWAY (number) » < « LINE UP FOR (A TAKE-OFF FROM) RUNWAY (number)»

« AIRBORN (rime) » < « YOU WERE AIRBORNE AT (time) ».

The choice of a preposition always depends on the relation the speaker wishes to establish between two facts, two objects, a fact and an object, etc. In the examples given above, the natural-language requirement to establish this relation overtly is made redundant by the extralinguistic knowledge of the aeronautical context common to controller and pilot. From a purely syntactic point of view, the relational structure of the utterance is now covertly vehicled by the invariant linear juxtaposition of the groups in question (verb + complement, noun + complement, etc.).

b) Of deletion, e.g. . :

« QFE THRESHOLD RUNWAY (number) (number) » < « THE QFE AT THE THRESHOLD OF RUNWAY (number) IS (number) »

« MAKE ALL TURNS RATE ONE DEGREE PER SECOND » < « MAKE ALL TURNS AT THE RATE OF ONE DEGREE PER SECOND ».

Once again, the resulting linear noun juxtaposition brought about by OF deletion suffices to convey the semantic content of each phraseological utterance.

c) Adverb deletion, e.g. :

« TRAFIC (number) O'CLOCK (number) MILES ON FINAL » < « YOU HAVE TRAFIC AT (number) O'CLOCK (number) MILES AWAY ON ITS FINAL APPROACH ».

This is the only case of adverb deletion in the phraseology, and can perhaps be explained by the fact that « AWAY » is both redundant and directionally imprecise even in natural English.

d) Fronting, e.g. :

(i) « FOR IDENTIFICATION TURN RIGHT HEADING (number) » < « TURN RIGHT TO HEADING (number) FOR IDENTIFICATION »

(ii) « IMMEDIATELY TURN LEFT (number) DEGREES » < « TURN LEFT (number) DEGREES IMMEDIATELY ».

Here, there is a modification of normal word order. Although this can occur in natural English for stylistic and syntactic reasons, one would not expect to come upon it in this type of utterance, as the English speaker's natural tendency is to give an instruction before qualifying it. However, in the three-dimensional aeronautical context, with its inherent considerations of speed and safety, the fronting process allows the controller to justify his instruction before giving it. This in turn allows the pilot extra time to gauge the validity of the manoeuvre before performing it (i above), or focuses his attention on the degree of urgency of the manoeuvre (ii above).

The only remaining syntactic regularity in the phraseology concerns WHEN deletion in subordinate time clauses, e.g.:

(i) « REPORT PASSING (significant point) »

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LINGUISTIC SECURITY IN THE SYNTACTIC STRUCTURES OF AIR TRAFFIC CONTROL ENGLISH *(contd.)*

(ii) « REPORT LEAVING (level) »

Here, WHEN deletion produces a phase structure involving juxtaposition of an imperative and a present participle clause, with consequent ambiguity :

(i) « REPORT WHEN PASSING (significant point)»
or « REPORT THAT YOU HAVE PASSED (significant point) »

(ii) « REPORT WHEN LEAVNIG (level) »
or « REPORT THAT YOU HAVE LEFT ».

The major difference between WHEN deletion and other types of deletion previously described is that the linear juxtaposition process does not suffice to convey the message unambiguously.

However, this syntactic ambiguity, which could theoretically result in the pilot's report actually being filed at two quite different points in time and space, is again resolved by the pilot's awareness of the aeronautical context. He will therefore file his report when passing a significant point, and not after passing it.

Finally, there does exist in the phraseology, a small number of inconsistent utterances in which the systematic modifications set out above do not occur : these must be considered as oversights :

« YOUR STAND (or GATE) designation) » (No determiner deletion)

« SAY YOUR FLIGHT LEVEL » (No determiner deletion)

« HOLD AT (name of facility » (No preposition deletion)

« STOP IMMEDATELY » (No adverb fronting)

8. Conclusion

We should like to end this paper with a quote from E. Johnson, Director of Wolfson College Communications Unit at the University of Cambridge. He describes the ICAO phraseology, with its official communications procedures, as « probably the world's most successful semi-artificial international language » (6). In fact, the « semi-artificiality » of the ICAO phraseology, as we have attempted to show here, can be partly explained by the fact that it incorporates a subgrammar (or special-purpose grammar) of English, as evidenced by the systematic nature of its syntactic modifications.

The properties of such a language subsystem have been informally defined as follows by R.I. Kittredge (7) :

> « The language subsystem is used in reference to a particular domain of discourse, or family of related domains ...

the set of sentences and texts in the language subsystem reflects the usage of some 'community' of speakers, who are normally linked by some common knowledge about the domain (facts, assumptions, etc. which goes beyond the common knowledge of speakers of the standard language...

the subsystem has all the 'essential ' properties of a linguistic system, such as 'consistency', 'completeness', 'economy of expression', and so forth...

the language subsystem is maximal with respect to the domain, in the mathematical sense that no larger system has the same properties. »

Paradoxically, the brachylogical search for clarity, precision and lack of ambiguity in the phraseology (8) results in a pronounced tendency towards ellipsis (in the widest sense of the term), rather than, as might have been expected, towards forms of linguistic redundancy (9). This observation may better be formulated as a question : how is it that a codified language such as the phraseology, which sets out to be explicit, can be so elliptical ?

The answer to this question has already been hinted at : the fundamental mechanism that allows the phraseology to function effectively as a communication tool is surely to be found in the interaction between its intra- and extralinguistic levels. The phraseology in fact interweaves two systems : the structural system of an English subgrammar and a system of referential values common to its domain (air traffic control) and to the speech community within this domain. If it were not for this interwoven complex, communication would be jeopardised and linguistic security put a risk.

(6) F.A. Robertson, *Airspeak*, Prentice Hall, 1987 (p. viii)

(7) *The Significance of Sublanguage for Automatic Translation,* in « Machine Translation », Studies in Natural Language Processing, Cambridge University Press, 1987, pp. 56-60

(8) Cf. *Radiotelephony Manual,* Civil Aviation Authority (CAP 413). 1984. P.9

(9) Cf. J. Lyons. *Introduction to Theoretical Linguistics,* Cambridge University Press, 1968, p. 85 ff. For an account of semantic and statistical redundancy

SOURCES

Nick Growse of IPSE COMMUNICATION presented the interactive computer-based course his company has recently developed to train pilots on radiotelepony phraseology in English.

Plane Talking is a computer assisted learning method for pilots and flight crews. It teaches standard English phraseology for international radiotelephony as defined primarily by the I.C.A.O. (PANS RAC/501/12 and Doc 9432-AN/925), although it includes variants from the British C.A.A. and the F.A.A.

The basis of the programme is the coordination of sound, text, image and recording which allow the user to simulate live ATC/pilot dialogues. It also includes a wide variety of linguistic exercises and phraseology notes, a talking dictionary and a « black box » programme which records details or the user's work sessions and test results.

The programme runs on any IBM compatible (80286 processor at least) with hard disk, 4 MB RAM and VGA screen. It requires in addition a sound card (Sound Blaster or equivalent) and a CD-ROM drive. Plane Talking is a Windows 3.1 application.

Plane Talking is divided into 2 modules :

Module 1 : Phraseology

31 lessons which have been constructed with an eye not only to the chronology of a flight, but also to progressive difficulty and a feasible learning curve ; after take-off, there is a progressive study of climb instructions, vectors, navaids and beacons, speed, position reporting and finally a synthesis of all these elements in a full climb situation. Bad weather ATIS reports, pre-flight clearances, and emergency situations, which require a good general grasp of phraseology, have been place at the end of the module. Module 1 includes 1150 screen pages, 987 exercises and 517 dialogues.

Module 2 : Simulated Flight Dialogues

Whereas Module A is designed to teach phraseology, Module 2 allows the student to put the phraseology into practice and tests his/her performance by simulating complete flights. There are 15 flight headings including 5 fictional flights (based on pure ICAO phraseology and British accents), 3 departure and arrival situations in London drawn from real flight transcripts and 7 complete flights within the U.S.A. using classic F.A.A. phraseology. With the visual support of en route charts, SIDs, STARs and airport ground maps each flight is as realistic as possible. There are 804 screen pages with 281 exercises and 274 dialogues.

In all, Plane Talking consists of 1954 screen pages or 90-120 hours of work, depending on the user's speed and knowledge.

The main innovation of Plane Talking is the way the computer takes the role of the controller while the user

Sample sceen from Phraseology Module of Plane Talking"

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BLENDING IN AVIATION TERMINOLOGY

Kitka T. Toncheva

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There exist different points of view concerning the place of blending or telescopy among the other ways of word formation. Some linguists identify it with word formation, others with abbreviation. There is one more opinion, i.e., blending is a completely independent phenomenon. E.N. Bortnitchuk believes that these different opinions stem from the fact that this way of word formation is very recent - it has appeared in XXth century - but it as attracted the attention of contemporary linguists by its ever growing occurrence. Words created as a result of blending express different ideas and phenomena in the field of science, technology, space research, transport, aviation, everyday life and almost all other branches of human activity.

A characteristic feature of blends is that their creation is undoubtedly intentional. Another feature is their predominantly American nature. In aviation terminology and documents an increase in the number of blends is also observed. This can be easily explained. As in the other branches of technology, progress in aircraft construction needs words, reflecting achievements based on older ones. For example, the word ELEVON, which combines the functions of ELEVATOR and of AILERONO and at the same time reflects this new function visually and aurally.

So, blending can be considered as a way of word formation where the new word is created by blending the full stem of one constituent with a part of the stem of the other constituent or by blending parts of the two stems of the constituents. The meaning of the new word includes in itself fully or partially the meanings of the constituents.

Quite a lot of blends have an accidental character because they are connected with a given situation and often are not included in dictionaries. Sometimes such words live for a very short time, especially when they belong to the colloquial style of language. The difference between blending and the other ways of word formation is that with blending one element at least does not participate with its full stem (1). Unlike abbreviation, blends have no correspondence in free phrases. Besides, under «a part» of the stem different numbers of letters from the stem should be understood - from most of the word to a few or even one letter of it, as in AVIGATION, a blend from AIR + NAVIGATION.

Taking into consideration everything mentioned above, we can conclude that blending could be considered a specific way of word formation. Some important features which make blends different from other morphologic abbreviations are:

1. Specificity or relation between constituents - it can be simple, i.e., meanings of constituents are of equal importance and both of them are reflected in the new blend:

   EVEVON from ELEVATOR + AILERON. But the relation could be complex, when meanings are not mechanically united, as in HELIPORT, from HELICOPTER + AIRPORT.

2. Possibility for superposition of morphemes as in AVIAGATION, from AIR + NAVIGATION, where A from AIR is superimposed on a A in NAVIGATION.

As for the structure of blends, a close survey shows four types of structure (1). They have been specified by Professor U.A. Zhluktenko my means of 4 letters, corresponding to the parts of constituents. As a rule, blends consist of two elements, i.e. two constituents. Every constituent is further subdivided into two parts that participate in the creation of a new word, a blend, but not in the same sequence.

The basic construction models for building blends are four and they are represented by the letters, A, B, C and D.

1. **Model (AV+CD=AD).** This pattern means that the initial part of the first constituent blends with the final part of the second constituent. Examples:

   RADAR + BEACON = RACON; ELEVATOR + AILERON = ELEVON; AILERON + ELEVATOR = AILAVATOR; HELICOPTER + AIRPORT = HELIPORT; TRANSMITTER + RECEIVER = TRANSCEIVER; ZIGAG + INDEX = ZIGDEX; AVIATION + ELECTRONICS = AVIONICS; VERTICAL TAKE-OFF + AIRPORT = VERTIPORT.

   We can call such blends « full » because constituent stems blend most intensively. Sometimes it is difficult to separate the components of such formations.

2. **Model (AB+CD=ABD)**. Here the pattern represents blending, where the full stem of the first constituent blends with parts of the stem of the second constituent. Look at the examples :

   SEA + AIRPLANE = SEAPLANE ; SNOW + NOTAM = SNOWTAM ; ROTOR + AIRCRAFT = ROTORCRAFT ; AIR + NAVIGATION = AIRGATION ; SAIL + AIRPLANE = SAILPLANE ; TURBINE + HELICOPTER = TURBOCOPTER.

3. **Model (AB+CD+ACD)**. This is the pattern which represents blending where a part of the stem of the first constituent blends with the full stem of the second constituent, for example :

   HELICOPTER + PAD = HELIPAD ; HELICOPTER + SPOT = HELISPOT ; HELICOPTER + BORNE =

BLENDING IN AVIATION TERMINOLOGY... *(contd.)*

HELIBORNE ; HELICOPTER + LIFT = HELILIFT; NAVIGATIONAL + AID = NAVAID ; CEILING + METER = CEILOMETER ; PARACHUTE + TROOPS = PARATROOPS ; PARACHUTE + GLIDER = PARAGLIDER ; SUPERSONIC + JET = SUPERJET.

Blending of the second and third model can be called « partial », because the new formations do not contain the full stems of both constituents.

4. **Model (AB + CD = A $\frac{B}{C}$ D)**. This pattern represents a formation which contains a superposition of morphemes at the very place where the two constituents blend. As a result, in the new word the middle part, which sometimes can be only one letter, is a part of both constituents, for example :

   AIR + NAVIGATION = AVIGATION ; NAVAL + AVIATION = NAVIATION ; ORNITHO + HELICOPTER = ORNITHOPTER ; AIR + RADIO = AIRADIO ; TRANSMITTER + RESPONDER = TRANSPONDER.

Sometimes additional letters are put in to facilitate pronunciation, as in TURBOCOPTER and CEILOMETER.

If we take a close look into the semantics of blends, we can easily notice that according to the type of semantic relations between constituents and also between the meaning of the new formation and the meaning of the constituents, three basic groups of blends can be identified.

1. Blends, the meaning of which is a sum of the meaning of both constituents :

   ELEVATION + AILERON = ELEVON ; AILEVATOR = AILERON + ELEVATOR ; ZIGZAG + INDEX = ZIGDEX ; TRANSMITTER + RECEIVER = TRANSCEIVER ; TRANSMITTER + RESPONDER = TRANSPONDER.

2. Blends, the meaning of which is not equal to the sum of both constituents meanings, although it is to be found in their stems. Such a meaning is more complex and gives additional information : ORNITHO + HELICOPTER = ORNITHOPTER ; VERTICAL TAKE-OFF + AIRPORT = VERTIPORT.

3. Blends in which one constituent adds to the meaning of the other one and makes it fuller and more exact. Usually the second constituent is the basic one, for example :

   HELICOPTER + PAD = HELIPAD ; NAVIGATIONAL + AID = NAVAID ; PARACHUTE + TROOPS = PARATROOPS ; SEA + PLANE = SEAPLANE, etc.

Most of the blends are single formations and their separate elements do not repeat themselves with the same meaning in other formations. However, among them there are blends that create structural-semantical models for designating a common element HELI - HELIPAD, HELIPORT, HELISPOT ; HELISKIING, HELILIFT, HELIBUS, HELICOP or PARA in PARAGLIDER, PARATROOPS, and TRANS in TRANSPONDER, TRANSCEIVER.

As a second common constituent element we can mention NAVIGATION in AVIGATION, AIRGATION ; PORT in HELIPORT, VERTIPORT ; COPTER in TURBOCOPETER, ORNITHOPTER ; JET in SUPERJET, SCRAMJET, TURBOJET. We can suppose that these kinds of formation lead to consolidating some structural semantic models for designating certain phenomena.

Aviation blends as nouns predominate over other parts of speech. In the last years blends have been becoming more and more numerous in the terminologies of different branches of science and technology, compared to the past, when blends had a more colloquial character.

Considering all these features of blends, we could assume that blending or telescopy, as a phenomenon, is an independent way of word formation, although there are some elements of abbreviation and traditional word formation in the process. Study of blending shows that this specific type of word formation is an intentional linguistic activity and recently has proved very productive with the prospect of being even more productive in the future. ■

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SOURCES ... *(contd.)*

becomes the pilot. The situation is presented in the information box on the screen. The user may talk to the controller by pressing the record button. When he releases the button the controller replies. Thus the user has the impression of a live exchange. When the exercise is finished he has all the elements necessary to make his own analysis : he may listen to his version, compare it with a model, both textual and recorded, and consult explanatory notes or the talking dictionary.

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TRYING TO CONCLUDE

The density of information and ideas at the seminar made if difficult to draw any conclusions on the spot although members could only benefit from the wealth of experience about CRM and human behaviour generally.

However, the vocation of the Association is not just to glean information, but also to attempt to draw certain lessons which will enable people working within aviation to understand the place and workings of language a little more clearly so as to meet language requirements more appropriately.

It was revealing to see how during the discussions which followed the papers, most of the questions asked concerned factual details rather than the use of language *per se*. Language is everywhere, yet language is elusive.

In each case study, the same observation can be made : it is almost impossible, even if it were desirable, to separate language from culture, age, environment, etc. As far as language is concerned, this points to the keystone position that language occupies in human behaviour. As far as teaching is concerned, this suggests that we should rethink how we can teach language. In a nutshell, language is never just linguistic.

Clearly, there is no single conclusion and undoubtedly more questions are raised than are answered, which is in itself a healthy situation. For the non-pilot however, CRM is important too because it provides us in very concrete terms with a model of human behaviour which comes closer to respecting the inherent complexity of human activities. It pleads in favour of multiple causality and the need to integrate the various human factors. If it is true that after CRM no pilot can be satisfied with only the contents of his operating manual, it is no less true that no teacher can turn only to his grammar book !

REVIEW *(contd.)*

While aviation awaits an improved RT interface sometime in the next millennium, it has to live with perfectible machines and, at least to an extent, incorrigible human beings. Chapter nine provides some proposals on how our present fate could be improved but concludes by returning to man himself. « As with any problem, awareness is the first key... Much of what we take for granted about language and communication in everyday life is simply false. The processes through which people communicate and understand each other are more complex than they superficially appear to be. Training should include some sophisticated discussion of the social and cognitive aspects of these processes and the ways these aspects can interact to lead the processes themselves awry, as revealed in the examples in this book. »

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