Human Factors in Soaring

Ian Oldaker,
Chairman, Flight Training & Safety Committee

As long ago as 1940, three-quarters of all flying accidents were noted as due to human failure. At the 20th IATA conference in Istanbul in 1975, these numbers were reported as applying to the more recent accidents also. Since then, accident statistics for general aviation in the United States show human failures to be responsible for an equally high fraction of accidents.

At the 1975 conference there was little appreciation that "human factors" was important from an aviation safety viewpoint. However, this conference was perhaps the turning point in recognition of the importance of human factors in air transportation. A conclusion from that conference was that unless human factors was to be taken more seriously and implemented in the aviation community in general, a major disaster would occur. In fact, this was followed 17 months later by the double 747 disaster at Tenerife. This accident resulted entirely from a series of human factors deficiencies.

Accidents to gliders are a subject fraught with difficulties of interpretation and opinion and, in Canada, the yearly analysis varies considerably from year to year. Insurance premiums are on the rise due to recent large claims. Unless Canadian pilots reduce the numbers of severe accidents over several years in a row, insurance may be hard to obtain in future, and more onerous regulations and checking of pilots by the authorities may occur. Looking at numbers of fatalities internationally, the Canadian situation might appear to be acceptable. Analysis of the fatal accident statistics from 1976 to 1995 and comparing the results to many other gliding countries shows Canada to be at the wrong end of the list overall.

The numbers of pilots per accident, gliders per accident or launches per fatal accident show us to lag, generally well behind. For example, the Netherlands had over 145,000 launches per fatality in a 23 year period whereas Canada's number is about 34,000 launches per fatality in 19 years. Lack of Canadian flight statistics is a hindrance to making good comparisons, but attempts have been made to extrapolate from when we had much better records to work from. The average for the 12 countries analyzed is approximately 74,500 launches per fatality. A total of 59 million launches were recorded. Canada recorded one fatal accident per 1508 members in 19 years. Only Finland did worse with 1344 members per fatality in 22 years. Best performer was Norway with one fatal accident in 23 years per 9081 members.

Canada's standing in the international tables is also a measure perhaps of the overall accident situation in Canada, of our approach or lack of a positive attitude to safety matters, all leading to the recent high level of insurance claims. Perhaps it is because our standards have not kept pace with the expectations of today's pilots, and indeed may have slipped so much that we have had some accidents that have had serious consequences. We certainly should not have had them in the first place, but having had them, we must now take action to prevent them from happening again.

We need to take positive action for two reasons; first to avoid having these accidents again, and second to prevent the insurance rates from increasing further. If more serious accidents were to occur soon, we may have great difficulties getting any insurance at all! It is for these reasons that our safety program is being enhanced and this paper is written to discuss where human factors can help us. Human factors are increasingly being recognized for their application to safety in all branches of aviation and indeed to other disciplines and industries.

What are Human Factors?

This paper describes human factors as it may be applied to gliding and soaring, and suggests there are many areas where individuals, clubs, and national organizations can apply this relatively new technology to improving safety.

Human factors is about people and their relationships with, and how they interact with their environment, with machines and equipment, and with each other. Human factors study:

- increases our awareness of human limitations and behaviour
- reduces consequences of human error by better design of equipment and procedures
- improves the quality of leadership
- minimizes environmental effects on personal well-being and effectiveness
- modifies attitudes favourably, and
- enhances motivation

Human factors is concerned with human behaviour and performance, with decision-making and cognitive processes. Ergonomics is the study of people in their working environment, and the discipline can be traced to time and motion studies in the 1880s and 1890s. WW1 stimulated human factors work when women entered the work force and production methods had to be optimized. At the same time, recruits in the USA were given intelligence tests to help assign them effectively within the range of needed military tasks. From 1924 to 1930, studies at the Hawthorn Works of Western Electric in the USA showed people would be influenced by psychological factors unrelated to the work. Thus motivation was seen to be important to good performance at work, in addition to the man/machine interface.

Human factors, then, is a multi-disciplinary technology that relies on many sciences:

Physiology and psychology are important for our understanding of how we see the world and how we hear, feel and react to things around us.

Biology gives us information about our body rhythms that affect performance, and for our eating and drinking needs. Did you know, for example, that humans suffer from a reduced activity level around lunchtime, whether we eat lunch or not? Airline pilots know this well, as it is now included in their HF courses.

Biomechanics is the discipline used in cockpit design.

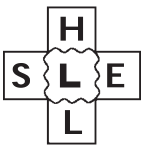
Genetics may explain why certain ethnic groups differ from others, and how they are expected to perform.

Engineering provides us with time and motion studies and of course with the designs of gliders that we fly.

Statistics come into the picture too, because we need to be able to knowledgeably review studies and surveys.

Human factors is the discipline that should be used to solve problems, in our case in our everyday soaring, and in our club operations and organizations.

To explain the scope of human factors, a simple model was first devised by Edwards in 1972 and refined later by Hawkins in 1984. It is the *SHEL* concept — each letter referring to the *Software, Hardware, Environment*, and *Liveware*. Take a look at the Transport Canada study guide for the glider pilot exam; section 8 is on HF.



Liveware

At the centre of this model is the human or Liveware. We are the most flexible component of the system, also the most valuable – but we have limitations. We know about many of these and can now generally predict human performance. Note that the edges of the central square are rough — they are not smooth and simple — the interfaces between us and the other components are not as smooth as we would like! Hence there is a need to match the other components to the human if stress and breakdown are to be avoided. To obtain a good match we need to understand how we operate, to understand our performance capabilities and our limitations.

Humans vary in size and shape. We vary by ethnic, age, and gender groups, and we vary within these groups. The designer must understand these differences to make design decisions. All pilots must understand how these differences affect glider performance to maintain safe operations. In extreme cases these factors have been implicated in gliding accidents.

We need fuelling with food, water, and oxygen. Deficiencies in any one of these can lead to serious problems in flying.

Data or information processing requires us to gather, process, and make decisions about the vast amount of information that is available. Hence, our decision making is to be followed by data processing. Input data processing output. I think you will agree that the output characteristics of individuals vary greatly. It is important in the aviation environment to understand how our memories (short and long term) work, how stress affects us, and how we are motivated. This is because many human errors can be traced to the area of information processing. Our tolerance to the immediate environment affects how we feel, our well-being. Although we function best within a narrow range of light levels, temperature, noise, etc, we often fly in more difficult conditions. These can adversely affect our performance. Some of us have a fear of heights or claustrophobia, or we get bored easily. These affect a pilot's mental and physical performance.

Decision making is addressed in the SOAR technique that we have included in our Association's flying training syllabus for at least the past five years. If you are not teaching this, ask your CFI to teach it to you! It is interesting that the military and civilian flying training programs include similar techniques that are taught to cover pilot decision making! What could be simpler than SOAR?!

We can expect large variations in the performance of individual pilots. This is not so with the gliders themselves because it is possible to design a glider to a set of internationally accepted airworthiness standards. The gliders of each design will be very consistent in their performance. In air forces and airlines, unsuitable candidates can be rejected, but in typical gliding clubs we have to deal with the difficulty of large variations between individuals. This means that our overall system must be designed with procedures, administrative controls and even training programs to give us a safe operation.

The Liveware is central to the SHEL model of HF. The other components must be designed to match and to be adapted to the human.

Liveware / Hardware

Matching hardware to the characteristics of humans concerns tasks such as seat design. More complex is the design of displays to match the information-processing capabilities of humans (the Liveware). Positioning of controls, too, is important — we can all think of incorrect actuation of a control due to wrong movement, or improper coding, or poor location — all human factors considerations. Humans, too, can and must be taught to adapt to poor L / H matching. But this does not remove their existence; they will remain a potential hazard. Of course designers must be alerted to these problems. How do we do this?

In our training of new pilots and checking out of pilots on new types the above points need to be emphasized. We must point out the problems of the Blanik flap and spoiler handles for example, the reversed direction of operation of undercarriage levers from one glider to another, and so on. Making pilots, from the start of training, look at the divebrakes when they check them on downwind, and to look at the undercarriage lever pictogram that shows it is down and locked, sets them up for good habits for all their later flying. The positioning of instruments from one glider to the next in a club fleet should be *identical*! I have seen otherwise. A safety audit should pick up this problem. But don't wait until then, check this now!

⇨ **p13**

Human factors in soaring

from page 11

Liveware / Software
Procedures, manuals and checklists, and their design are important in this interface. In the cockpit, symbols or pictograms are used to indicate control function and position, and are largely universal. But rules in gliding clubs are potential areas that need more attention to reduce the hazards from poorly conceived club procedures and rules. How many rules are unwritten for example? Think about it and you will probably come up with some… "*we* do it this way…" Take a look at your past incidents and look for operational factors. This may suggest some rules need to be amended. See Terry Southwood's excellent article in *free flight 2/98 p8*.

Liveware / Environment
This interface was considered very early in flying, when pilots were fitted with special suits, goggles, etc. Oxygen systems and 'g' suits came later. In commercial flying today, the environment is controlled to suit the people, but in gliding this is not totally possible. Hence there is a need to adequately train pilots in the important areas of nutrition, health (and I include smoking and drinking here), the use of drugs, and the need for oxygen for high altitude flying. It is important too, to cover the effects of long exposures to the airfield environment at weekends (wind, sun, heat) by people more used to working in an office all day. Some aspects of human needs should be considered, especially how food and adequate water are needed to optimize our performance. Oxygen use and the regulations for its use are obvious areas for exam questions. Ground school courses should include discussion and presentation of these factors.

Liveware / Liveware
Traditionally it is the pilot's performance that is questioned in this Liveware / Liveware interface. However we need to include consideration of leadership in clubs, and personality interactions. Student/instructor and pilot/club management interactions are very important when training and guiding the pilot's responses under difficult circumstances, to most effectively solve his or her immediate problem in the safest manner. Of course, individual responsibility must continue to be expected of all pilots, and our training programs must be geared to achieve this. What I mean here is that on a first flight the instructor is fully responsible for all decisions and for the safety of the flight. On a first solo flight the student pilot is now responsible for all his or her decisions and the safety of the flight as well as others involved. Transferring this responsibility to the student is a gradual process and it takes a lot of care by instructors to be sure that the student, when solo, has the knowledge and skills to do this effectively.

This short paper will serve hopefully to introduce the reader to the subject of human factors in soaring. Having stimulated your interest, we can advance the cause of safety by more detailed study of each interface and by sharing details of training and other programs in each of our clubs. If you know of items that may be added to the above subjects, or you have a contribution, please let me know, and we can advance the safety of our sport. ❖

Journal of the Soaring Association of Canada ISSN 0827 – 2557