SOME EXPERIENCE IN ULTRALIGHT FLIGHT TEST

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1. INTRODUCTION

This paper describes the research activity, and some of its results, now being conducted at Dipartimento di Ingegneria Aerospaziale del Politecnico di Milano, in conjunction with Prof. H.W. Smith of the University of Kansas. This cooperation was established during the past year to get deeper knowledge of some aerodynamic phenomena of sail wings, as the most used in ultra light motorgliders (ULM) and their correlation with structural loads, to help compiling an experimental data base to be used both in ULM design and during static tests on their structures.

2. PREVIOUS RESEARCH

At the beginning of the hang glider activity, at our Department was started experimental research on the behaviour of delta sail wings by means of stereo Hi-Fi recorders [1], but such analog recording techniques were unsatisfactory, restricted as to number of channels (only six) and not useful for subsequent elaborations.

So we prepared a digital data acquisition system whose main characteristics were lightness, cheapness and future expansibility [2]. This system was built around a very common microprocessor using an industrial bus to get standard expansion cards. Actually software can support up to 240 channels (30 cards of eight channels each) in voltage up to 2,5 volt. Some working tests were made on the ground during static tests on an ULM with traditional wings [3].

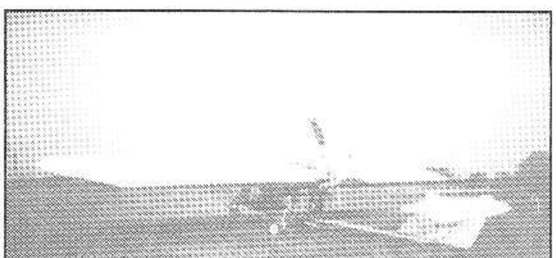

FIGURE 1.

3. ACTUAL RESEARCH

At the same time a two-place side-by-side ultralight was projected and built, according to classical aeronautical methods, trying to meet actual Italian rules (the same as in U.S.) about ULM. In Figure 1 you can see this prototype on the field ready for the first flight (without any skin). This prototype was submitted before to static tests on the ground to verify project structural limit loads, with load cells on the cables and on the tubes of trailing and leading edges. The wing was mounted upside down and loaded by means of a cable attached to each rib, joining together by a hydraulic jack (Figure 2).

Table 1 shows a comparison with project loads, NASTRAN loads and test loads.

Then a first series of flight tests was made to confirm aerodynamical project assumptions: in Figure 3 you can see some plots of those quantities.

The flexibility of our acquisition system allows us rapidly to elaborate data on the field after the flight, by means of a download of data on a portable computer or on a laptop (Figure 4). So we can change next test flight program to investigate some particular problem or repeat some test not well recorded.

We soon found that, while the global project was confirmed (except for gross weight) and obtained

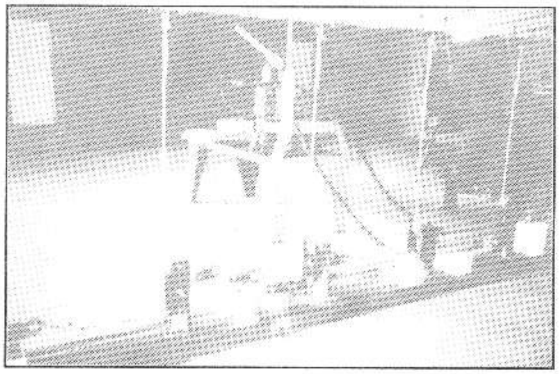

FIGURE 2.

min. and max. project velocity, local pressure distribution disagreed with our assumptions due to obvious deformation of the fabric. In fact there was an appreciable difference in airfoil behaviour between cruising speed and stall speed due to the difference in angle of attack.

Another fact we found different from our project was the propeller performance. To acquire propeller thrust, we mounted a load cell on the last support of the propeller shaft (Figure 5) obtaining plots as in Figure 6. While the static thrust equalled that stated by the constructor, the cruising performance was poor, penalizing the whole ULM performance. A normal

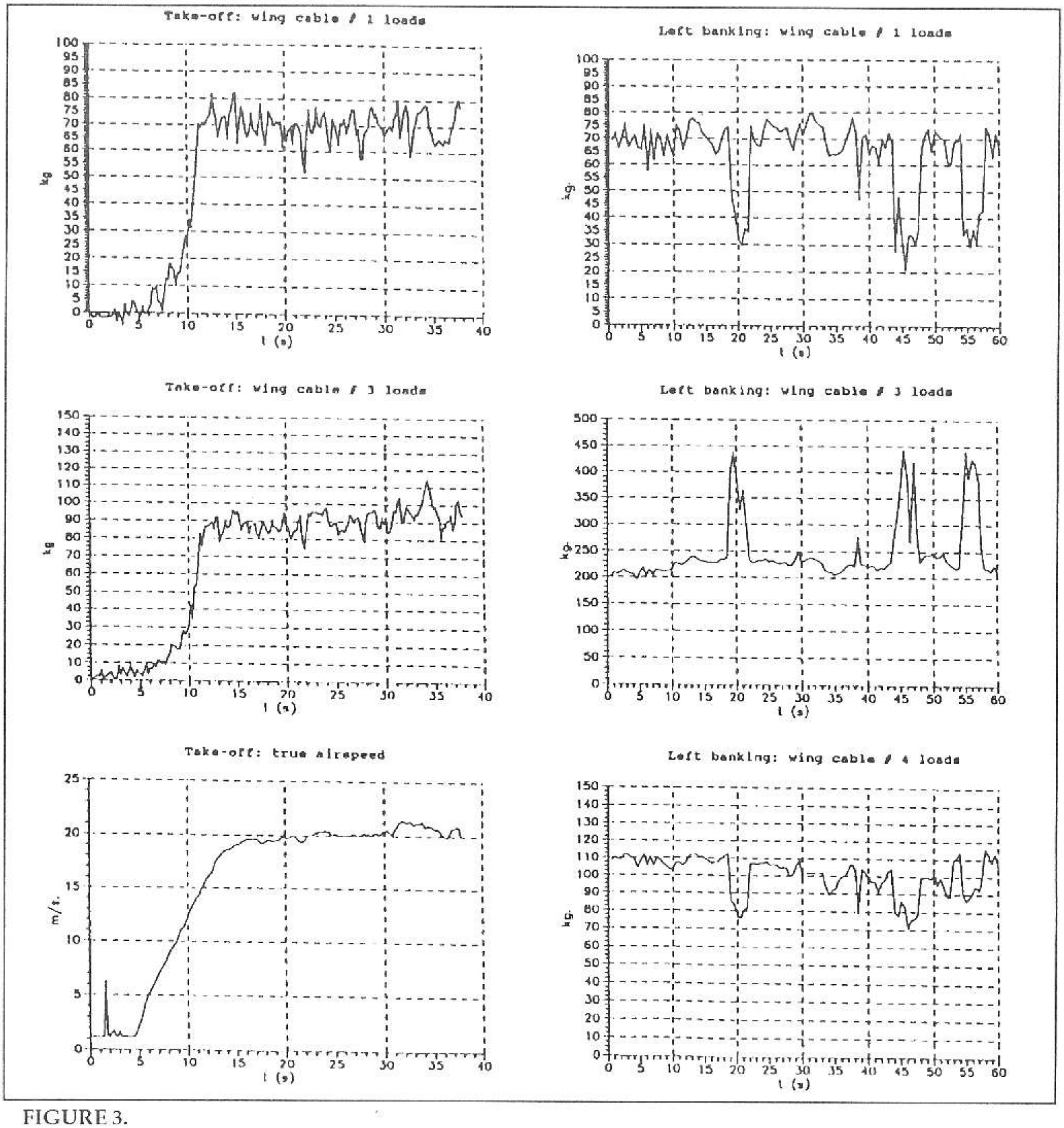

FIGURE 3.

Load cell	NASTRAN loads n = 3.8 Kg.	SAP loads n = 3.8 Kg.	TEST loads n = 3.8 Kg.
A	-217.0	-204.6	-211.4
B	127	140.0	100.4
C	-26.9	-27.2	0.5
D	-70.7	-61.1	-25.3
E	70.7	59.5	67.0
F	513.2	397.0	475.5
G	401.1	608.4	377.8
H	173.8	88.6	223.9
I	213.5	276.5	160.0
L	653.2	599.0	633.4
M	375.1	358.8	390.0
N	144.8	148.9	103.0

Table 1

practice among ULM pilots is to look for the best propeller by means of a personal feeling during some flights, but without any instruments (except anemometer or engine rpm). So we are now conducting a

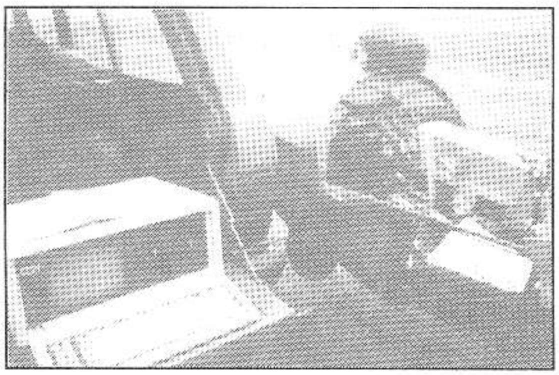

FIGURE 4.

research to elaborate a computer program to design a propeller from given engine power and rpm at given TAS, to be tested then in flight on our ULM.

Also a joint research was outlined with the University of Kansas where Prof. H.W. Smith was conducting research on the behaviour of sail wings with tunnel tests [4]. The aim of this joint research is to build a big data base about ULM with sail or rigid wings, comparing laboratory tests with flight tests, for incorporation in the standard aeronautical bibliography.

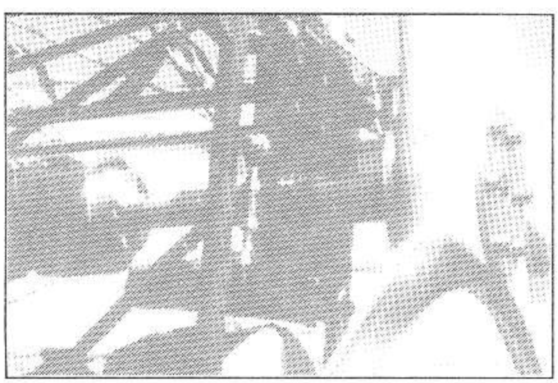

FIGURE 5.

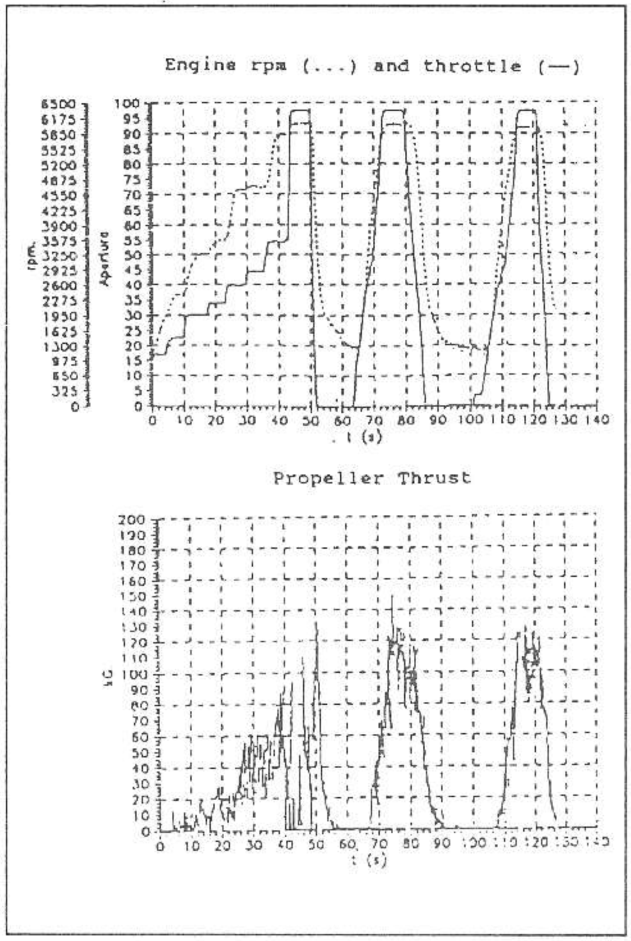

FIGURE 6.

To conduct this research we modified our digital recorder with a new storage support, more capable and reliable, as well as new CMos processor to save battery life and total weight. Figure 7 shows the layout of this new system and Figure 8 shows a partially mounted rack with CPU card, memory card, LCD display and 9 card analog input of eight channels each for a total of 72 channels.

With this new system, by means of new pressure transducers so small as to be mounted directly on the wing surfaces, we want to acquire local pressure on the airfoil. At the same time we should acquire, by position transducers mounted on a dummy rib, the airfoil shape during the flight, so correlating elastic deformation of sail with local pressure distribution.

3. CONCLUSION

With this paper we have tried to give you a brief overview of the whole test program we are conducting at Dipartimento di Ingegneria Aerospaziale del

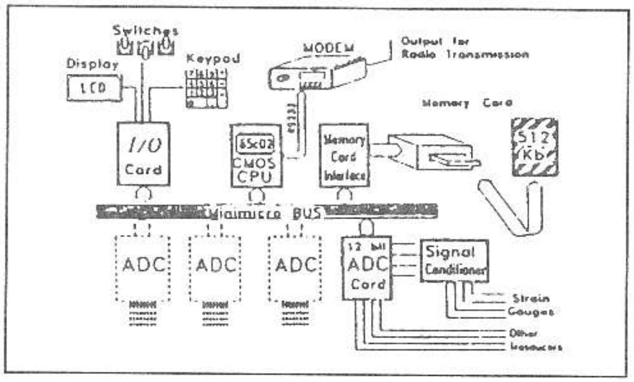

FIGURE 7.

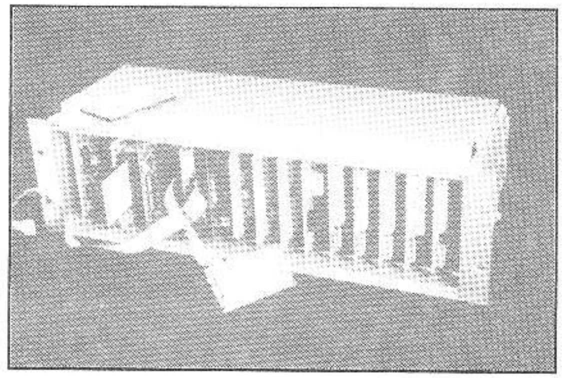

FIGURE 8.

Politecnico di Milano, and some typical results of the first tests conducted. In our country as in the U.S. there are petitions to modify actual rules concerning ULM. Our effort, with the aim of collecting as many data as possible about these flying machines, is to bring a valid contribution to anyone setting new limits, to give more flight safety, saving life and reducing injury.

BILIOGRAPHY

1. C. Caprile, T. Merlini, L. Salvioni (Politecnico di Milano) "Analysis of load acting on a hang glider as based on test flight surveys," *L'Aerotecnica Missili e Spazio*, Vol. 62/n.4/Dec. 1983.
2. A. Folchini, R. Picardi (Politecnico di Milano) "Instrumentation for ULM and Hang Glider Flight Tests," Flight Test World Wide Congress, Amsterdam, Sept., 1987.
3. Silvio Lora-Lamia "Esame di laurea per l'altra aviazione" *Volare*, luglio/agosto 1988.
4. H.W. Smith (Kansas University) "Static Test of an Ultralight Airplane," *J. Aircraft*, Vol. 25, No.1, Jan., 1988.