Summary of Papers presented at the XXX OSTIV Congress at the World Gliding Championships, Szeged, Hungary, 28 July – 4 August 2010

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The opening ceremony and reception of the XXX OSTIV Congress was conducted in the briefing hall for the competition at 8 pm on Wednesday, **28 July**. It was initiated by welcoming comments from Mr. András Gyongyösi, President of the Hungarian Gliding Association and Competition Director, Dr. Lásló Bozo, Director of the Hungarian Meteorological Service and Prof. Dr. Peter Ryder, President of the Jury WCG 2010. After a brief OSTIV Awards Ceremony, the President of OSTIV, Prof. Ir. L.M.M. Boermans of TU Delft, presented the keynote address, "Aerodynamic Developments for Sailplanes at Delft University of Technology."

The presentation of papers began the following afternoon, Thursday **29 July**, with the first lecture being presented by Matthieu Scherrer (Airbus, Industries, Toulouse, France) and entitled "**Computational Fluid Dynamics (CFD) in sailplane design, LS6 winglet design experience**." The paper was co-authored by Stefan Melber-Wikending (German Aerospace Center, Braunschweig, Germany). This paper examined the design of a conventional-style, retro-fit winglet for installation on an LS-6a/b. The major design trade-off of decreasing the induced drag more than the profile drag is increased was emphasized, but other design issues, such as consideration of the multipoint mission, trim drag, and three-dimensional tip flow aerodynamics, were also explored. It was found that these latter considerations can be just as important for maximizing performance as the former. A high aspect ratio winglet planform was selected as the starting point, along with a large radius wing-to-winglet transition region. From this point, a simple optimization tool was used to determine the most suitable chord distribution, sweep angle, dihedral angle, and toe/twist angles. Most interestingly, the flight-template tool was employed to bring actual logged flight data into the design process. As is usually the case in aerodynamics, the optimum curves were fairly flat, although handling qualities and flutter also need to be taken into account. At this point, plain tips and winglets were analyzed using the Reynolds-Averaged Navier Stokes solver, TAU, which is currently in use at Airbus. The laminar-to-turbulent transition model employed in this code is not too reliable, so the results presented were the product of running it in the fully turbulent mode. Thus, absolute values cannot be used with confidence, but changes in performance due to a change in geometry (deltas) should provide useful guidance. Overall, it was concluded that while CFD can be useful in capturing some of the gross features of winglet aerodynamics, it does not account for anything that is influenced by laminar-to-turbulent transition.

Next, Francios Ragot (Montifort, France), in "**Total energy I**," gave an excellent and detailed discussion of energy exchanges between a glider and the atmosphere. He began with a review of total energy calculations and the theoretical foundations behind them. In particular, the aspects of dynamic soaring were considered in detail and a number of examples presented. The theoretical development behind this presentation is quite rigorous and those interested should consult the full paper. The consequences of this analysis detail the benefits of extracting energy from gusts, in which to maximize the energy gain the pilot must pull up in upward gusts, push over in downward gusts, and pull sideways into horizontal gusts.

The second part of Francois' presentation, "**Total energy II**," dealt with the unreliability of existing total energy variometers in turbulent and vertically moving air. Part of this unreliability is a consequence of pilots being unaware of the dynamic energy exchanges that occur in various gust situations. In addition, modern variations are sensitive to headwind and tailwind gusts that change glider airspeed, whereas the inertial speed is unchanged. On the other hand, these variometers are insensitive in real time to accelerations occurring when an inertial wind is perpendicular to the glider speed. That is, present-day variometers are only accurate if all the air particles are moving at the same speed, and when this speed is horizontal. Thus, modern variometers tend to mislead pilots in searching for thermals and are totally unsuitable for achieving dynamic energy gains. These explanations were followed by suggestions for pilot reactions to counter these deficiencies in various situations. In addition, an assessment of the errors made by present-day variometers in turbulent and vertically moving air was presented. It was noted that some of these errors result in a significant loss of performance. In any case, it was noted that technologies are now available which would allow the development of an entirely new and reliable variometer.

After the mid-afternoon break, Wolfram Gorisch (Akaflieg München e.V., Technical University Munich, Germany) gave his paper "**Glider's rate of climb exerted by atmospheric turbulence**." In this presentation, the question was examined of how glider performance is affected by the presence of large-scale gusts that occur in the atmosphere. The well-known Katzmayr effect, in which gusts in the upward and downward sense both produce a force component in the thrust direction, was discussed. From this point, the mean rate of climb resulting from transitioning a gust cycle (upward plus downward gust) was developed. Neglecting aircraft accelerations, it was found that for a glider of typical dimensions, a ±1 m/s gust results in a climb rate of roughly 0.5 m/s. Finally, an instrument was proposed that would allow the pilot to monitor the load produced by turbulence.

The next paper, "**Validation of CFD transition models for use in sailplane wing/fuselage design**," was presented by Johan Bosman (Jonkers Sailplanes, South Africa). In this presentation, the impact of a new model for transition in the CFD process was addressed. In particular, the k-kl-w turbulence model was examined, which accounts for the growth of Tollmien-Schlichting instabilities and is employed in the ANSYS/FLUENT Navier Stokes solver. For the most part, two-dimensional calculations demonstrated reasonable agreement with the experimental measurements and XFOIL predictions. However, the CFD calculations did not seem reliable for predicting the maximum lift coefficient or the corners of the laminar drag bucket. Three-dimensional calculations on the wing/body of the Mü31 sailplane also were performed and compared with wind-tunnel results. For these cases, flow-field predictions were in close agreement with those obtained experimentally, and, while the lift predictions were in close agreement with the experiment, the drag results were not.

The first paper of the second day of the Congress (Friday **30 July**) entitled "**Experimental study of lightness factors and loading abilities with sandwich structures**" was presented by Miro Rodzewicz (Warsaw University of Technology, Warsaw, Poland). This paper began with a description of the strength-lightness and the stress-lightness factors for composite fabrications in order to develop the criterion for the lightest possible structures that can support the required loads. Towards this end, general experimental investigations were conducted of various composite shell structures having different laminate/configurations and materials. These experimental results were compared with finite element calculations (NASTRAN) and considerable agreement was found. In the end, the stiffness-to-weight ratios for the different shell configurations were examined, and several methods of improving the load carrying capabilities were explored. For example, a reinforced foam-core sandwich, laminate-shell structure subjected to shear loads was compared to a pure sandwich structure. It was concluded that when lightness is most important, it is necessary to apply reinforcement inside the foam core.

Next, Richard Millane (University of Canterbury, Christchurch, New Zealand) presented a paper entitled "**Measuring 3-D wind-fields in mountain waves using sailplane flight data**." The paper was co-authored by N. Zhang, A. Hunter (both also from the University of Canterbury), E. Enevoldson, and J. Murray (both from the NASA Dryden Flight Research Center, Edwards Air Force Base, California, USA). The idea of this work is to use a glider sensing platform to obtain meteorological data. While the interest here is to map three-dimensional wind-fields in mountain-waves, the concept has many other interesting applications. The low-cost system for making such measurements centers on the development of an algorithm that allows the extraction of the desired data using GPS and airspeed data (with optional pressure and temperature data) or using GPS data only. The details of the algorithm development were discussed with special emphasis regarding a clever method of extracting the estimated horizontal wind velocity from the available GPS and airspeed data. Basically, to obtain the horizontal wind velocity, the flight path is partitioned into cylindrical regions of suitable size, and the algorithm run on pairs of data points within each case to estimate the horizontal wind speed. The glider's vertical velocity is obtained correcting the GPS data for vertical air motion and the glider's sink rate. The only restriction is that the glider flight path cannot be too straight. The methodology was applied to the Perlan project wave flights and the estimated wind directions were in good agreement with the closest available radiosonde measurements. Finally, how similar data could be obtained in the absence of airspeed data was outlined.

Just after the mid-afternoon break, Gerhard Waibel (recently retired from Schleicher Sailplanes, Poppenhausen, Germany) presented his paper entitled "**Load relief for light and small sailplanes**." The motivation for this work was to determine if the current airworthiness requirements for sailplanes (OSTIVAS) should be modified to better accommodate the design and development of lightweight and small sailplanes. The insights provided by this work indicate that if aerobatics are intended, then the requirement should not be modified. However, if the aircraft is to be used as a glider certified in the utility category, then some relief is possible. In particular, it is possible to reduce max loads factors at the design dive speed to +5.3 and -2.65. In addition, the design load factors to withstand gusts as they are currently specified remain appropriate. If operated in same atmospheric conditions as certified sailplanes, then the structural loadings introduced by the environment will also be the same. In this case, for the same level of safety, the current regulations remain appropriate and some relief is provided by the lightweight and low operating speeds of these aircraft. The one outstanding issue that remains is whether or not the critical gust loads requirements for the lightweight glider should be made greater or less than those of the current regulations.

Likewise, the ability for lightweight sailplanes to “escape” strong lift, to avoid excessively high altitudes and dangerous situations, should be addressed.

The next paper of the day entitled “**The effect of water absorption on the performances of composite materials**” was authored by Attie Jonker, but presented by Johan J. Bosman (both from Jonkers Sailplanes, South Africa). This work dealt with the effect on the structure and structural bonds by water absorption. For example, is it necessary to dry water-ballast tanks after use, etc.? Several experimental specimens were made, immersed in water for a period, and the increased mass measured. It was found that composites do have infinity for water and should be dried out after a weekend or week of competition. Next, the tensile strength of specimens was measured after water immersion. It was found that, while carbon, glass and Kevlar all had reductions in tensile strength over time, carbon had the worse degradation with an 18-precent reduction in tensile strength over a period of several months. Finally, the bond shear strength was measured before and after immersion in water and a 26-percent average decrease after 6 months was observed.

To conclude the day’s presentations, Mark Maughmer (Penn State University, University Park, PA, USA) talked about “**A new airfoil concept**.” This presentation was co-authored by Dan Somers (Airfoils, Incorporated, State College, PA, USA). In this talk, a slotted natural laminar flow (SNLF) airfoil concept was introduced in which the aerodynamics are such that, at sailplane Reynolds numbers, the forward element of the airfoil has 100-percent laminar flow, as does 70-percent of the rear-element upper surface and its entire lower surface. As confirmed by wind-tunnel studies, the results showed a remarkable 18-percent reduction in profile drag and an 18-percent increase in maximum lift coefficient over the values measured on a single-element airfoil designed to the same mission requirements. While this particular design was not specifically targeted for a sailplane, the operating conditions are similar enough that the results were used to predict the impact on the performance of a hypothetical Standard-Class sailplane. Although it remains to specifically apply the concept to a sailplane airfoil design and to explore how full-span ailerons and the mounting fixtures influence the performance, the results thus far are interesting.

Saturday **31 July** was a free day. Sunday (**1 August**) was the day for the traditional OSTIV excursion.

Presentations resumed on Monday, **2 August**. The first two papers of this third lecture day were authored by Gottfried Sachs, Jakob Lenz, and Florian Holzapfel, and were both presented by Johannes Traugott (all with Technische Universität München, Garching, Germany). The first paper was entitled “**Wind effects on maximum-range saw-tooth flight**.” The goal of this research was to determine the optimum height strategy to minimize fuel burn for retractable propeller and/or engine motor gliders in different wind conditions. The problem was formulated as one of optimal-control theory. The optimal altitude gain under power and the total distance flown during cycle were determined. While the overall results are essentially as expected, the work provides the details necessary to actually perform the optimum saw-tooth cycle. One specific operational feature found was that the best result is obtained with the altitude gain achieved using the maximum power setting. Compared to steady flight, the saw-tooth yields is 66-percent reduction in the amount of fuel used. The analysis is repeated to determine the optimal results in various wind conditions, and similar piloting strategies were presented.

The second paper of Sachs, Lenz, and Holzapfel was entitled "**Maximum range performance of electric motor glider with retractable engine**." This paper was related to the previous one and also was presented by Johannes Traugott. For electric motor gliders, the analysis is somewhat different from that of the previous case, in that a cooling-down period is not required. In addition, as motor performance does not depend on air density, the power available does not reduce with altitude as is the case with a reciprocating engine. This difference results in the optimum solution having a higher altitude gain during the climb than that obtained for the piston engine. The total energy savings for the electric powered motor glider using the optimum saw-tooth trajectory is nearly 69-percent over that of sustained flight.

Johannes Traugott, also gave the third paper of the day, but this time on a different subject. The paper was entitled "**Flight recording of dynamic soaring in albatrosses using miniaturized GPS loggers**" and was co-authored by Gottfried Sachs and Florian Holzapfel. The goal of this research was to learn more about dynamic soaring and to better understand the interesting flight of the albatross. As the wandering albatross covers long distances over water without flapping (day and night), it is somewhat of a mystery as the whether or not they achieve this performance solely by dynamic soaring using the shear layers generated by the wind over ocean waves. As differential GPS or other schemes that achieve high precision was not possible, an algorithm was developed to determine the bird's trajectory using only the raw logged GPS data. Twenty different birds were equipped with miniature loggers and, of these, sixteen made long-distance trips. Although the trips lasted much longer, batteries lasted long enough to record forty flight days. Remarkable measurements were obtained of detailed flight trajectories for albatrosses performing dynamic soaring. All in all, the cycles were similar to what has been thought over the years although, contrary to what has been assumed, the maximum altitude achieved during a dynamic soaring cycle is considerably higher than the wave height. Also, it was found that the total energy decreases close to the sea surface and increases at higher altitudes, and there is a continuous change of energy from the low to the higher heights. Finally, vertical winds and gusts due to waves seem to play a minor role in the albatross' performance. The aerodynamic force performance was backed out of the trajectory information, and it was found that the bank angles performed were a reasonable ±40 degrees, the drag force was always dissipative, as expected, and the net energy gain was equal to or greater than the dissipation due to drag.

After the mid-afternoon break, Lukáš Popelka (from Academy of Sciences, Prague, Czech Republic) presented the paper "**Parametric study on flapped airfoil lift enhancement by vortex generators**." Co-authors of this paper were Natálie Součková, David Šimurda (also from Academy of Sciences), and Milan Matějka (Czech Technical University in Prague, Czech Republic). The goal of this work was to achieve the lift enhancement generally obtained with a vortex generator, but to reduce the height, which is typically 0.5 of the boundary layer height, to about 0.1 of the boundary-layer height. These vortex generators were placed at chord locations of 0.56c and 0.65c. At the test Reynolds number of 200,000, it was found that unsteady flow/laminar separation bubble interactions made meaningful measurements difficult. Thus, the remaining experiments were conducted with transition fixed near the leading edge. All in all, it was found that each airfoil/flap configuration must be studied to determine the optimum vortex generator configuration.

Having the same authors as did the proceeding paper, Lukáš Popelka also gave the next presentation entitled **"Sailplane aerodynamics syntheses of computational fluid dynamics, wind tunnel and in-flight testing**." This paper contained the computational and experimental tools currently available in the Czech Republic for the development of sailplanes. In particular, several design codes exist, two wind tunnels and gliders are available for flight testing. A number of interesting results obtained with these tools were presented. The in-flight testing performed to improve the effectiveness of control surfaces was especially noteworthy. Likewise, some promising work on wing/fuselage juncture aerodynamics was presented, as well as the results of several flow-control applications. Finally, some early looks at a number of new sailplane designs were presented.

The last lecture of the day, "**Non-mesocyclone tornadoes in Hungary**," was given by Zoltan Polyanszky (Hungarian Meteorological Service, Budapest) and co-authored by Gyula Bondor (Hungarian Association of Stormchasers and Storm Damage Surveyors, Budapest). This paper first dealt with the relatively weak tornados produced by storms that did not contain meso-cyclones. Then, the occurrences of stronger tornados was considered. It was found the presence of a convergence boundary and the horizontal shear across it occured in conjunction with the development of cumulus clouds. Along the convergence there is vertical vorticity circulation. Super-cell thunderstorms and super-cell tornadoes were preceded by a midlevel meso-cyclone and the subsequent tornado development occured when the meso-cyclone intensified. The inflow that occurred produced tornadoes, some of which were quite strong and produced substantial damage. The particular meteorological conditions which produce such tornadoes and funnel clouds were discussed. These conditions were analyzed in detail, to determine if a hydrostatic weather model could predict such situations, and the range of values of the most important parameters which could produce tornadoes was presented. At this point, a detailed case study was considered, and it was found that conditions corresponding to the development of meso-cyclone tornadoes could be predicted by local parameter values and the synoptic situation.

The last day of papers, Tuesday **3 August**, got underway with a presentation given by Roel Baardman entitled "**Cumulus humilis: wireless mesh- networking for gliders**" that was co-authored by Nirvana Meratnia (both from Twente University the Netherlands). The concept of a wireless mesh network is one in which a firm tree structure does not exist, but rather connections between nodes is dynamic and changeable. The relevance to gliders is that the computers in individual gliders can be networked so that information can be gathered and exchanged between them. Obviously such a capability has many applications, from more easily finding a downed sailplane to informing pilots of weather developments over a task region. The paper continued with a discussion of the problem and challenges that introducing such a system would entail. Using existing GPS logger data from typical days in the Netherlands, the possibilities of a wireless glider network was explored, and a strategy to overcome problematic situations and develop a reliable system was devised. Problems with connectivity were explored and, in poor conditions, there could be a considerable time delay before information is exchanged. In general, however, such a system could perform quite satisfactorily.

The next paper entitled "**Applications of statistical models and artificial neural networks (ANN) to define onset and organization of thermals**" was presented by Zafer Aslan (Istanbul Aydın University, Istanbul, Turkey) and co-authored by A. Tokgözlu (Süleyman Demirel University, Isparta, Turkey). At present, it was noted, gliding activities are based on the convection potential of a soaring day. Rather than using the traditional modeling approaches, neural networks "learn" by feeding back the actual conditions being measured to those being predicted. For this purpose, air temperature variation, sunshine duration, and solar radiation data obtained at two locations in Turkey from 1975 to 2009 were analyzed to determine what the variation of these parameters was over the years. Based on predictions obtained using the artificial neural network methodology, it was predicted that, because of increases in solar radiation and duration, the temperature will continue to increase over the next several decades. As a consequence, it is also expected that more dry thermals will exist over this period. The last part of the paper considered some large scale effects such as the North Atlantic Oscillation on to temporal variations of variables.

Before the break, Atila Fövenyi (Hungarian Meteorological Service, Budapest) gave a presentation entitled "**Making thermal activity forecast at the Hungarian Meteorological Service**" [The paper appears on pages 103-109 of this issue]. In this presentation, weather forecasting at gliding championships in Hungary was explained. An overview of how soaring weather is predicted was presented, along with the details of the decision-making schemes used with these predictions that are unique to Hungary. In addition, visibility, synoptic forecasting was discussed, as were other tools used in forecasting. From this information, cloud cover maps are constructed, as well as time cross-section plots of predicted conditions for various locations. Of interest is the forecaster feedback, in which pilots report back to the forecasters what they experienced. This feedback system, in place since 1996, has helped to refine the forecaster's predictions.

After the break, Christoph Kensche (Hexion Specialty Chemicals, Stuttgart, Germany) talked about "**Requirements for resin systems for gliders**." After a brief introduction describing the roles of the fibers and the matrix in a composite laminate, along with the importance of the interface between them, the construction of hand lay-ups used in glider manufacturing was discussed. After this, an interesting historical review of the development of composite sailplanes was presented. He noted that resin systems were developed early on for use with glass fibers, but that after the introduction of carbon fibers for sailplane structures, new resin systems had to be employed. All of these systems had to be replaced in 1985 due to new environmental regulations. Since then, operational requirements over the years have become better understood and are much more far-reaching than those suggested originally, such as the need for properties that accommodate hostile environments (water and temperature). At this point, a newly developed resin system was introduced that satisfied all of the requirements for sailplanes, including good physiological compatibility, good mechanical and thermal properties, a wide range of available "pot lives" (depending on the amount of hardener used), a long shelf life and non-toxicity. Finally, shrinkage issues as caused by the difference in the shrinkage between the fiber and the resin with temperature changes were minimized with the new resin system.

The next presentation entitled "**Indirect effect of Saharan dust aerosols on high level clouds not well represented cirrus shields which may ruin thermal activity**" was given by Kornel Kolláth (the Hungarian Meteorological Service, Budapest). The effects were presented on weather due to mineral dust emissions into the atmosphere. The largest source of these emissions is sand from the Sahara. The direct effect of these emissions is the absorption and scattering of solar and infrared radiation. Indirect effects deal with cloud condensation nuclei and ice nuclei. These nuclei may produce high-level cloud shields and result in less precipitation efficiency. The research described explored the presence of Saharan dust in the atmosphere, including how the dust gets there and its effect on the Hungarian weather. From satellite imagery, the development and spread of these aerosols in the atmosphere was studied, as well as how the aerosols affect the development of cirrus/cirrostratus cloud shields. The dust above the level of cloud formation has a dramatic effect on the clouds that do develop. Specifically, for example, clouds developing in these situations can last much longer and are less likely to yield precipitation. For soaring, the presence of the dust can weaken thermal convective activity.

The last paper of the Congress, authored by Jozsef Gedeon and Sandor Dora (Budapest University of Technology and Economics, Budapest, Hungary), was the "**State of the Natural Parameter Method (NAPM) for chaotic data analysis and modeling**" [The paper appears on pages 94-102 of this issue]. Because neither of the authors was able to attend, this paper was studied and presented by Zafer Aslan. In this paper, the characterization of aircraft loads is approached in three ways: the traditional deterministic approach, a stochastic approach and in a new way of examining the data using a chaotic approach. These different characterizations flow smoothly through chaotic from completely deterministic to completely probabilistic. In this regard, a chaotic analysis can provide useful information between the deterministic evaluation and a random one. A code, NAPAM, is a record analysis method of chaotic character that starts from the stationary and ergodic process mode. It gives considerable improvement in accuracy as well as saving in computer time and in memory space. At present, the frequency analysis and the rating of similarity stand in the center of the development work.

The evening of **3 August**, an OSTIV lecture, "**Safety pays!**" was presented in the WGC briefing hall by Helmut Fendt and Eric de Boer.

The OSTIV General Conference was held on the afternoon of **4 August**. At the closing dinner that evening, Roel Baardman was presented with a new award given for the best student paper presented at the Congress. At the conclusion of the dinner, farewells were made to old friends and new, and so ended the XXX OSTIV Congress.