

# M.A.R.C.S. SPARKS

Monthly Newsletter of the Madison Area Radio Control Society  
Madison, WI

AMA Charter # 665

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Minutes of MARCS General Membership  
Meeting, Aug. 7, 2003

## *Come Fly With Us*

MARCS meetings are held on the first Thursday of every month at 7:00 P.M. in Room 201B of the Madison Labor Temple, 1602 S. Park St. in Madison. Visitors are always welcome. We think we have a great hobby and we invite you to come and see and consider joining us.

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The MARCS web site contains links to War Birds and Electric Flyers Special Interest Group web sites

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Contribution of articles is encouraged. Deadline for submittal is the 20th of the month.

*By Burr Fontaine*

The meeting was called to order by Vice President Don Weigt at 7:10 p.m. with 38 in attendance. President Lanphear was unable to attend.

**Visitors:** Tom Bucky has a Gentle Lady and would like to get into electrics. Chris Rewey, Bill Rewey's son, has built rubber powered models many years ago and would like to try some small electrics. Robert Hayden has an LT-40 and is interested in war birds. Charlie Carll is another visitor tonight and is interested in flight instruction.

**New Members:** Sean Lynch is a new member tonight.

**July Minutes:** The minutes of the July meeting as printed in the August issue of SPARKS were accepted as published.

**Old Business:** Several flying events from this past month were reviewed. Dave Rush was cited for the excellent job he did organizing the Electric Fly. There were 41 pilots this year, double the number in 2002, and a large number of these were from outside the Madison area.

Jerry Buss thanked all who helped with the Boy Scout Fun Fly. Pictures of the event may be in a future one of Bill Oberdieck's columns in *Model Aviation*.

Charlie Schultz made special mention of the people that provided the food that was served at the Float Fly. A nice turnout of float planes provided some interesting, and at times exciting, watching.

**New Business:** The next club event is the 1.5 Meter Hand Launch glider contest at the Long Island Sod Farm on August 16. A map is in the M.A.R.C.S Handbook and on the Club's website.

Don Weigt said the plans for the Scale Rally on August 17 are complete. Setup will begin about 7:30 a.m. on the 17th followed by registration at 8:15. Dave Rush has organized the raffle to consist of 10 major prizes with a separate ticket jar for each prize.

Events in September include the Fall Thermal Soar at the Long Island Sod Farm on September 6 and Warbirds Over Dane at Kettle Field on September 20.

A visitor passed along a request he received from Cub Scout Scoutmaster to have a RC program at the Badger Prairie field on September 18. Don Weigt will try to gather more details.

**Raffle Winners:** Jerry Buss - GWS P-51 electric model; Sean Lynch - Gallon of fuel; Mike Kimmerly - Shirt; Bill Rewey - Cap; Jeremy Kelly - Cup.

**Show & Tell:** Show & Tell pictures are on the Club's website, [www.marcswi.org](http://www.marcswi.org).

Don Weigt brought a GWS P-51 and said with a 8 cell, 600AE pack he gets 6 minute flight times while doing loops and rolls. Don used Polly S model railroad paints and Scotch blue painter's tape for masking to add airbrushed invasion stripes to the craft.

Wendell Hottmann's Show & Tell is a "Miss Arco ARF, described by Hobby Lobby as an Aerobatic low wing aileron trainer for brushless power. Wendell used a 15-4 Phasor brushless motor for power.

Bill Kinney's new model is a Pilatus PC-9, used by the Royal Australian Air Force Flying Team. The assembly was straight forward except for the placement of the fuel tank which was inconsistent with the intended use of an inverted engine.

Greg Baer brought two models. One is an electric conversion of a Herr rubber band kit with throttle, rudder and elevator control. The second is an electric Kyosho Lear Jet. Greg has had only a couple of flights so far but is getting about 6 minutes with the 2500 mAh battery pack.

Dan Sutter also came with two models. One is a Herr P-51, Tuskegee Airman Craft that Dan intends to use with a brushless motor. The second is a scratch built, stand-off scale, Jaguare Jaff-2 jet. The present weight, ready for radios, is 28 ounces.

The meeting adjourned at approximately 8:45 p.m.

## Philosophy 101

What good fortune for governments that people do not think.

Adolph Hitler

## Thank You. Thank YOU! THANK YOU ALL!

*By Don Weigt*

This year's Ken Kindschi Memorial Scale Rally was a success, thanks to all the help from so many of you!

Somebody trimmed along all the fences. Lots of you helped set up before the event. The crews for each task were large enough that very little relief was needed: they rotated. Enough people helped with the tear down that it went quickly. I even saw Jerry Buss on a bench in the spectator area, visiting with someone! I've never seen that before during one of our events.

During the meet, several people asked me how they could help, and I didn't have anything for them to do just then. You should know that was a wonderful feeling for me, having some reserves, rather than scrambling to keep everything staffed. So, thanks to those folks, too.

Lots of people loaned the equipment needed, from the PA to tongs, to the water can for hand washing, to the gloves for the food handling, and of course, all those canopies that shaded many of the workers. Thank you all! Without your equipment, it would have been a very different event, and far poorer.

So, how did the event go? Pretty well. Attendance was down a bit this year, both pilots and spectators. Seems there was some competing Centennial Of Flight event in Indiana, for one thing. We had only 3 pilots who weren't club members, and 25 total. I hope we'll have at least 30 again next year.

The raffle seemed well received, and made a nice profit for the club. The food was good and sold quickly, though we didn't need all the extra food we bought when it seemed we were running short.

Fliers seemed to fly as much as they wanted, and the weather was good. There weren't many aerobatic planes this year, but the few there were real crowd pleasers. Two planes crashed, that I know of. There were a few lulls in the flying, which having more pilots might have prevented.

It was nice to have Dolly Wischer visit us again. She even donated one of her famous flying bears, which we gave away in a special kids' drawing!

BALSA USA brought a big trailer, which they set up near the center of the parking lot, and which gave spectators more to look at and pilots something else to do with their money! They had about a half dozen examples

## MARCS 2003 Calendar of Events

Event	Date	Location
Fall Thermal Soar	September 6	Long Island Sod Farm
Warbirds Over Dane	September 20	Kettle Field

of their various giant scale WWI model kits built up. They looked great sitting in a gaggle near the shelter!

The event wound down pretty fast in the afternoon, after the raffle at 12:30. I'm not sure why, though many pilots probably had flown enough and were getting tired. I had hoped the flying would continue until 3 P.M. or so, which was what I told the newspapers and radio and TV stations, but it was pretty well over at 2:00.

People seemed satisfied when the event ended. I think it was pretty entertaining for the spectators. Most people seemed to have a good time, and we made a decent profit for the club.

One more time: this year's event was much more fun for me because so many of you pitched in. Thanks, the event wouldn't be possible without you!

### War Birds Over Dane 2003

*By Mike Pirkl*

On September 20th, Saturday, the warbird special interest group the "Watson's Whizzers" and the Madison Area Radio Control Society will host its 3rd annual "War Birds Over Dane." The focus of this event is getting a bunch of R/C war birds of any era together and displaying and flying them. The landing fee is only \$5.00, but you need to be an AMA member to participate.

So what is a warbird? The R/C war birds which may be permitted to take part will be any military aircraft of any type flown by any military so long as it is in military markings.

If you've got a Midwest Mustang bring it. If you've got a Cessna 182 done up in Civil Air Patrol markings its welcome. An Aerostar .40 done up to resemble an L-19 still isn't a warbird. If you've got a Ryan STM in the markings of the Dutch training outfits bring it, but a Skywalker in training command colors isn't going to meet muster. Please don't bring a Hog Bipe in training colors and try to pass it off as a Stearman. A Beech King Air in Army markings will qualify. If you have a Cub in military markings it is welcome; but a AT-6 in one of the Reno racing color schemes doesn't fit

the bill. Hopefully these examples will give you an idea of what the guidelines are.

Your plane doesn't need to be a big dollar, giant scale monster. Any size RC model that fits the above definition of a military R/C model is very welcome at the event. We're really trying to do a couple of things with this event: Showcase the R/C war birds, have a nice get together to promote camaraderie, show a bit of history and first and foremost have a good time.

If you can make it, the flying starts immediately after the pilots briefing at 9 AM. Even if you don't have a plane you want to bring out you still may want to come out and see the planes that do attend.

We are looking for volunteers to help out with the different activities during the event. We need someone to step up and handle the cooking for the day and helpers for the cook also. If you want to help out elsewhere please contact the person heading up the particular activity or sign up at the next meeting.

Bill Kinney is looking for help on the flight line; Mike Piechowski will need backup with registration; Chuck Backman needs personnel for transmitter impound; and Dave Jeardeau could use a hand with the pilots parking in the morning.

If you have any questions or want to volunteer, contact Mike Pirkl at 608-877-0419, or e-mail at [maddog@chorus.net](mailto:maddog@chorus.net). If you want to check out pictures from the last 2 years of War Birds Over Dane stop by my web page at [maddogaviation.com](http://maddogaviation.com). There is a page there with more info on WOD-03 also.

### Let's Go To Marshfield

The Mid State Aero Guidance Club of Marshfield lost its field recently due to noise complaints by neighbors. They haven't been able to fly much for the past two years. Count your blessings, MARCS members!

Anyhow, they have acquired a new field that, according to Jim Rasmussen, their newsletter editor, sounds like a big improvement over the old one and they are having a fly in to celebrate their good fortune on Saturday, September 27, the week after War Birds Over Dane. Ed McDonald and I are going up and look in on it.

Why don't you join us? There will likely be folks there from a lot of other clubs as well and it sounds like there's a good time to be had with other RC nuts.

To get to the new field, go through Marshfield on its main street, Central Avenue, all the way to the extreme north end of town, where Central Avenue veers off to the right and becomes Hwy. 97. Follow 97 to Stratford. From the light there at the junction of 97 and 153, continue on 2 miles north, on 97. Then turn right (east)  $\frac{3}{4}$  of a mile and duck if you see a low flying plane coming at you.

Let's help another club celebrate its good fortune in having a field from which to fly.

## **They Crashed and Burned, I Guess**

I'm told that about two weeks ago there was a new kind of combat event over Kettle Field. Try as I might I haven't been able to discover who was involved in it, but it sounds like something I think I'll try to avoid.

Anyone who has been at the field lately knows that the land fill is a big dinner table for 500 to perhaps 1,000 sea gulls, a big flock of crows and about 20 turkey vultures - buzzards. Along about ten o'clock, when the ground gets well heated up, the buzzards usually form up in a large flock formation over to the west of the field and start searching for thermals. They begin at about a hundred feet and once they find what they are looking for, without a single wing flap, they are soon on a high perch, maybe a thousand feet up.

Anyway, as I understand it, one of them got feisty and took on an airplane to their mutual chagrin. Apparently they shot each other down, thereby reducing the buzzard population by one and the MARCS Air Force by an equal amount. The buzzard, I hear, was DOA in the middle of the field. The plane came down in pieces across the ditch, out in Never Never Land. Maybe we need to think about a new trophy for the Awards Banquet.

## **Whizzer's War Bird Report**

*By Craig Lovell*

Over the past few months, Chris Spierings has been passing along tips and techniques on how to actually start building your favorite warbird from that set of plans you've been admiring (really... it was him). Prior to that, he listed off some common tools of the trade that really help move projects more easily through the shop. This month, I thought I'd continue along those lines and add a few items to the list of tips.

Warbird projects often present some interesting problems that call for alternate solutions, or force one to try a different product. E6000 adhesive is one case in point. E6000 is a general purpose, industrial strength adhesive, targeted at joining a variety of dissimilar materials. It's clear, in theory paintable (although I haven't tried that myself), remains somewhat flexible when cured, and is very strong. The nice thing is that the stuff is relatively inexpensive and available from a number of chain stores (I get mine at JoAnn Fabrics). There are some similar adhesives marketed to modelers under some popular brands, which are nothing more than this stuff repackaged (and marked up about four times). E6000 has a lot of applications in our hobby, particularly when gluing things made of dissimilar material. This stuff says it will do glass, wood, plastic, metal, ceramic rubber, you name it. However, E6000 has fairly active solvents so it will dissolve foam, and the package doesn't recommend use on polystyrene, polyethylene, or polypropylene. That having been said, I have used it successfully on some of those materials. The important thing as always will be to try it on some scrap material first just to be sure it's suitable.

I was introduced to E6000 when looking for an alternative adhesive to use for attaching fuel tanks directly to fiberglass fuselages; an application where you need an adhesive to stick to the tank and fuselage wall equally well, but that will also remain somewhat flexible when cured (for vibration damping and glue joint stress relief). CA or epoxy either don't stick in this case or are too brittle when cured and eventually break away. Previously, I have used clear RTV as an adhesive for that application, primarily because it is quite flexible when cured and sticks to a variety of materials as well. The problem with RTV is that it's really a silicone sealing adhesive and doesn't have the long-term holding power. For instance, fuel tanks in a pressurized system tend to "breathe", basically they expand and contract as the pressure changes (tanks in my ducted fan stuff expand a lot under pressure). With RTV this "breathing" can actually work the tank loose from the adhesive and eventually cause it to let go (a particularly evil thing to have happen when the tank is immediately in front of the fan turning 26,000 RPM!!).

The E6000 in this application will not let go of the tank surface, particularly if it is scuffed up a bit with 80 grit sand paper, just enough to provide some "tooth" to the tank surface (yes, I used to do this with RTV and it still let go). Of course, the E6000 has no problem adhering to the fiberglass fuselage, which should also be

prepped with a light sanding (80 grit) and wiped clean with your favorite window cleaner or some alcohol. The interesting thing I noted is that I need to use much less E6000 as opposed to RTV. With RTV, you would basically put on a broad, relatively thick gob of the stuff so it had a lot of surface to bite into on both the tank and fuselage. This could get messy and the RTV would sometimes take a long time to set up. E6000 used on the same part can be applied in a series of beads, separated by air gaps. The extra adhesive holding power reduces the amount needed, and the air gaps help with curing. I have also found that when I need to remove a tank, the beaded application is much easier to separate using an x-acto knife or straight edge razor.

Since using E6000 for fuel tanks, I've started using it in a number other applications too, mostly to install system components in a fuselage or wing, particularly if you're running short of room and need to tuck items in odd locations. I secured air tanks for retracts, the retract valve/servo assembly, batteries, switch-harness etc. etc., anywhere you need it to stick and stay, and yet have some vibration damping. The fact that it sticks to virtually anything helps in that regard too. The one problem you run into is that some of these locations require that you hold the item in place until the E6000 cures enough to hold on it's own (about an hour or two). If you're like me, you're probably too impatient for that. This brings me to the second product I'd like to mention: Low-temp hot-melt glue.

Hot melt glue is nothing new, it's been around for a long time, in both hi-temp and low temp variations. Hot-melt glue has been mostly looked upon as a craft adhesive but over the last 20 years or so, an interesting variety of low-temp adhesives with different characteristics have been developed. The general-purpose low-temp hot-melts are actually quite strong and adhere to a wide variety of material as well. One unique characteristic is that they hold as soon as they cool, which makes them great for tacking things in place. This is how I hold some of the parts I mentioned earlier in place while E6000 or RTV cures.

Hot melt has a number of other applications as well. I have used it often to tack glue assemblies in place so I can test fit parts and trim them before final gluing. Using just a drop here and there allows you to assemble fairly complex structures, and then easily take them apart once you satisfied with fit. Who hasn't wondered what to do with all the wires and air lines and other stuff that flops around inside the model. I use hot-melt to secure these things to fuselage sides and formers so that their routing is

clean and they don't get tangled. I recommend wrapping some fabric tape or masking tape around the servo lead or whatever, and applying the glue there so that it's easier to remove the glue if you should need to. Removal isn't a problem either. Usually you can simply peel the glue apart or away from the mating surface altogether. Otherwise, you can use the hot tip of the glue gun to melt the joint (and reseal it later).

Low-temp Hot-melt glues are available in large and small diameter sticks and in various lengths. The only thing to watch out for is that you use a low temp glue gun with the low-temp sticks or you will have a real mess. The craft stores carry a variety of adhesive sticks as do some hardware suppliers. I recommend starting out with a general purpose adhesive if there is a variety, and also suggest the smaller diameter stick and gun, simply because the glue gun is smaller and easier to deal with. I wouldn't use hot-melt for anything structural and I would limit its use to a degree because it starts getting heavy in quantity (probably no more so than epoxy though), but otherwise your only limit is your imagination.

One last thing: I've been asked about some of my fuel tank installations particularly when the fuel tanks are located a fair distance from the engine. Well, you certainly can have problems but there are a number of ways I keep this from happening. Keep in mind that what follows relates to glow engines using the usual, common silicone fuel line. Gasoline engines and fuel lines are a totally different subject (and probably a different article). First, like most of you, I always run muffler or pipe pressure. This positively pressurizes the tank assisting fuel flow to the carb. Remember, the engine does generate some "draw" at the fuel inlet but its ability to draw varies considerably depending on a number of circumstances I won't go into now. Suffice it to say that muffler pressure often helps stabilize these fuel draw/flow issues.

A distant tank location can still present some flow issues due to the length of the fuel line. Believe it or not, the drag in the flow increases considerably at long lengths, not so much that fuel won't flow, but can be restricted enough that the flow is inconsistent and causes sensitivity in the needle-valve setting. I've seen installations where the fuel flow was so restricted that the engine would run too lean no matter what; even with the needle valve way on the rich side. The thing to do in this case is use the largest fuel line you can get for the run to the carb. I also increase the size of the line inside the tank and make sure that the feed-hole in the clunk is big enough (most are). This usually takes care of any fuel flow/draw issues. My

Spitfire had a large fuel tank located in the fuselage over the CG. This was mostly because there was little room in the nose. The run to the carb was over a foot in length. This required rather long lines, but with the use of large lines and muffler pressure, I had no fuel draw issues.

Now, some of you who have used the large fuel line will recognize that it fits way too loosely over the brass feed tubes supplied with the typical tank, and is also loose on some of the carb inlet and pressure nipples. There is a simple solution (and I'm sure you've all seen it before). What you do is cut off a number of 1/8" long pieces of fuel line to act as small bands. These bands are placed over the end of the fuel line pinching it against the tube or nipple. I'll use two per end about a 1/4" apart where the line fits over a tank tube, and one on the end of a line that fits a carb or pressure nipple. I use a pair of small long-nose pliers or a small forceps to stretch the band to place it over the fuel line. Works quite well.

Well, that's about it. Just a couple more items for your bag of tricks.

See you at the field.

## **The Long, Long Road to Kitty Hawk - III**

*By Jerry Buss*

I recall during the Cold War era that Soviet media charged that the Wright Brothers were not the fathers of flight. Rather, as you might expect, they maintained that powered heavier than air flight had been born in the Rodina. I also recall the American press ridiculing this notion, but there was a definite basis to it that was not given much credence in that era of paranoid international jealousy. The attitude was that, surely, it must be sheer communist propaganda and don't bother me with what's in the history books.

In 1854 **Alexander Mozhaiski**, a Russian naval officer, began experimenting with a machine that he hoped would carry him in flight. It was designed according to Cayley's concepts and was to be driven by propellers. He received some limited financial support from the government, but could not develop sufficient power from a wind up spring driven "engine" to produce flight. He tinkered with the notion for several years before the government lost interest and he could not afford to continue independently. In 1876 he again used a wind-up, spring powered device to drive an air screw. He mounted this in a small model that actually rose off the ground and flew, carrying a payload consisting of a sailor's dagger. This probably was the first heavier than air machine to actually rise off

the ground under its own power and fly, just as the Russkis claimed. Over the next year he experimented with larger models before concluding that, although he believed he could build a machine capable of carrying a man, his spring driven engine wasn't going to do the job. The government turned down his request for money to pursue a new power source, however.

In 1880 Mozhaisky began to develop a design for a man carrier despite the government's disinterest. It was a classic monoplane layout with an aft mounted horizontal stabilizer and a four wheel landing carriage. Persons who have assessed drawings of it have said the machine should have had fairly good aerodynamic characteristics and, given a satisfactory power source, should have been capable of flight. In 1882 he was finally lucky enough to get government assistance for the purchase of two steam engines from an English firm which built them according to his specifications. One put out 20 horse power and could turn up 300 rpm at a weight of 47.6 kilograms. The second put out 10 hp, weighed 28.6 kg and could turn at 450 rpm. While this all came to an endurable 76.2 kg or 168 pounds, there is much more to a steam engine than the engine. Adding the necessary boilers and fire boxes more than doubled the weight by adding a further 82 kg, or 180 pounds, bringing it to the considerable total of 348 pounds with no water yet added to the boilers.

A request for further financial aid was turned down by Czar Nicholas III, who saw no value in human flight. This compelled him to go on independently in finishing his airframe, but he did succeed in getting permission to use a military field at Krasnoe Selo near St. Petersburg to make his tests. He built a high fence around the site to keep out prying eyes as he approached the testing phase in 1883.

Shortage of money probably was at fault for the fact that the air frame turned out to be much heavier than Mozhaisky had planned and in addition to the considerable weight of the power plants this could well be what caused his failure. Before any actual attempt to fly was made the machine nearly shook itself apart due to the unbalanced state of the propellers. With props balanced, take off attempts on level ground proved futile; it simply couldn't achieve enough air speed to develop sufficient lift to raise its own weight. To permit gravity to assist in acquiring the necessary velocity he launched the craft from the top of a long, high inclined ramp with a ski jump-like bottom. Accounts vary on whether it actually flew on its own or if it just "jumped." Some accounts say it flew 100 feet and crashed into the fence, but in any case

the machine was utterly demolished. Whether it was on or off the ground when it hit the 6 meter high fence isn't agreed upon either. Who the pilot was, if it was piloted, and what his fate may have been is also unclear.

Not to be stymied, Mozhaisky ordered two new and hopefully lighter and more powerful versions of his larger, 20 hp, engine from the Obukhov Steelworks in St. Petersburg. With these and by constructing a lighter airframe perhaps he could fly, but it was too late. He died before the power plants were completed and there the most likely to succeed of Russian attempts to be first to fly ended.

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The steam turbine engine was invented by **Charles Parsons** in England. In 1883 he built a small quarter horsepower example and used it to propel a model airplane about 300 feet. He did not continue in his experiments and this flight had little or no effect on the development of flight, but it is generally regarded as the first flight by a jet powered aircraft.

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**Otto Lilienthal** and his brother, **Gustav**, were among the premier pre-Kitty Hawk pioneers. In any discussion about the history of flight, the Lilienthal brothers, and especially Otto, deserve to be mentioned alongside Cayley, Wenham, Langley and the Wrights.

Otto Lilienthal was born in Prussia, on the Baltic Seacoast. As children, he and Gustav often watched storks gliding along the shores of the Baltic. Their observations included the fact that when the birds glided in circles as they searched for fish, they rose when they turned into the wind, but never when going with the wind. Otto was educated as a mechanical engineer at the Berlin Technical Academy, graduating in 1870, but he never outgrew his interest in flight. He set up a factory in Berlin manufacturing steam engines and in his spare time pursued his aeronautical interests much as RC flyers today pursue theirs.

Lilienthal built rigid, fixed wing gliders and extensively studied the lifting ability of varying amounts of camber as well as airfoil form variations. In all, he produced more than a dozen and a half distinct glider designs and made more than two thousand flights, many longer than eight hundred feet. Many other experimenters were involved in gliding well before as well as contemporaneously with Otto and Gustav, but Otto's approach was markedly different. Others merely rode their machines wherever fate and the fickle wind took them. Otto Lilienthal, on the other hand, quite literally flew his under

control. He looked forward to making a powered flight, but believed that he must first gain considerable experience in flying an unpowered version of an aircraft before adding a propulsion system to it. **Hiram Maxim**, inventor of the Maxim machine gun as well as himself being an aeronautical experimenter of renown (his four ton monster machine powered by a 360 horsepower steam engine "hopped" briefly off the ground), called Otto a flying squirrel. Nonetheless, his 1889 book, *Bird Flight as the Basis of Aviation*, was widely read and influenced the Wrights heavily.

Although Lilienthal's experiments in airfoil design, especially his tables of lift, were groundbreaking, his method of control, swinging his legs and torso in order to shift the craft's center of gravity, was limited and difficult, it still resulted in his being the initial pioneer of control. In 1894, to promote his gliding attempts, he built a hill that he called Flight Mountain from which to launch himself and have more height to attempt maneuvers.

Still, Otto Lilienthal's dreams and experiments fell short of achieving powered flight. On Sunday, August 9, 1896, during a glide, a gust of wind lifted his glider's nose. Then the wind died and he was unable to get the nose down. The aircraft stalled and crashed heavily, injuring Otto Lilienthal grievously. He died the following day.

Some who have studied the Lilienthal brothers' experiments have said that, had Otto not been killed, he would surely have beaten the Wright brothers in being the first to achieve powered flight. These beliefs are almost certainly wrong, however, unless he would have revised his intended method of propulsion. Having studied birds so carefully, he looked to ornithopter systems that would cause the wings to flap or, alternatively, a system of movable slats at the wing tips that would produce propulsion once glider flight had been achieved by acting like oars on a boat. Neither of these systems could have worked.

Over the centuries, many men had died jumping off cliffs or towers while attempting to fly. Then there was Robert Cocking who made an illadvised jump in Cayley's parachute. Otto Lilienthal's death was the first of a man who was actually in flight. When people had pointed out the dangers of gliding, he said, "sacrifices must be made" and this epitaph is carved on his gravestone.