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Re engineering history: Flight of the Phoenix, what can we learn from a movie crash?

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On the 15th of December 1965 the motion picture "Flight of the Phoenix" was released in the United States of America theatres. In the closing movie credits the following text is shown: It should be remembered. . . that Paul Mantz, a fine man and a brilliant flyer gave his life in the making of this film. Who was Paul Mantz? What happened? And what can we learn from a movie crash? This paper will examine the Tallmantz Phoenix P-1 accident which was captured on film for the motion picture "Flight of the Phoenix". This paper will study the "Flight of the Phoenix" story, the people involved and the special purpose aircraft build. Literature will be reviewed and analyses will be done to gain new insights to the crash of the Tallmantz Phoenix which occurred on July 8th 1965.

I. Introduction

The Flight of the Phoenix is a 1964 novel by Elleston [1]. The book was based on a United States Air Force B-24D Liberator from the 376th Bomb Group named "Lady Be Good" disappeared without a trace on its first combat mission during World War II. The B-24D was believed to have been lost—with its nine-man crew—in the Mediterranean Sea while returning to its base in Libya following a bombing raid on Naples on April 4, 1943.

The B-24D "Lady Be Good" wreck was accidentally discovered 710 km (440 mi) inland in the Libyan Desert by an oil exploration team from British Petroleum on November 9, 1958. An investigations concluded that the first-time (all new) crew failed to realize they had overflown their air base in a sandstorm. The aircraft flew on a 150 degree course toward Benina Airfield. The aircraft radioed for a directional reading from the HF/DF station at Benina and received a reading of 330 degrees from Benina. The navigator likely took a reciprocal reading off the back of the radio directional loop antenna from a position beyond and south of Benina but 'on course'. The pilot flew into the desert, thinking he was still over the Mediterranean and on his way to Benina. After continuing to fly south into the desert for many hours, the crew bailed out when the plane's fuel ran out. The survivors then died in the desert trying to walk to safety. All but one of the crew's remains were recovered between February and August 1960. The wreckage of the Lady Be Good was taken to a Libyan Air Force base after being removed from the crash site in August 1994.

The Flight of the Phoenix 1964 movie was based on the novel with the same title but called for a cargo plane with a dozen of men on-board to go down in a sandstorm while overflying the Sahara. One of the passengers is an airplane designer who comes up with the idea of ripping off the undamaged wing and using it as the basis for an airplane they will build to escape. Just like a Phoenix this airplane is resurrected and flown out of the desert. In the movie closing credits epilogue: It should be remembered. . . That Paul Mantz, a fine man and a brilliant flyer gave his life in the making of this film. On July 8th 1965 while filming the flight of the phoenix the Tallmantz P-1 aircraft crashed in front of camera's while performing an aerial movie sequence. Paul Mantz, the pilot, died when the aircraft crashed.

II. People

This section will provide background information on the people who were involved in the accident with the Tallmantz P-1. The first paragraph will discuss the life of Paul Mantz, the pilot who flew the Tallmantz P-1. In the next section Otto Timm, the designer of the Tallmantz P-1, will be discussed. And finally Frank Tallman who is the connection between the Tallmantz P-1 design and operation for the movie picture.

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A. Paul Mantz (1903-1965)

On August 2nd, 1903 Albert Paul Mantz was born in Alameda, California. At a young age Paul was interested in flying. Using the money he earned during the influenza epidemic in 1919 he took flying lessons. However when Mantz witnessed the death of his instructor he quit flying [2]. After getting persuaded to join the U.S. Army in 1927 Mantz learned to fly (again), he did not tell about his previous flying experience. While flying his solo graduation flight he spotted a train heading west over the empty desert. He rolled over into a dive, levelled off a few feet above the track and flew head-on towards the train as the engineer repeatedly sounded the whistle. At the last moment Mantz pulled up, did a "victory roll" and flew away [3]. It seems he buzzed a passenger train full of high-ranking Army officers who were on their way to attend the graduation ceremonies[4]. Because of this stunt he was discharged just before his graduation for reckless flying. Reportedly his instructor encouraged him to continue a career in aviation.

Mantz found it difficult to break into movies because he was not a Associated Motion Picture Pilots (AMPP) member. However when in July 1930 he set a world record of 46 outside loops he was noticed and soon after became a union member. In 1931 Mantz started his own flying and charter business United Air Services in Burbank, California with two others. From this point on his movie flying career took off. Mantz is credited with his stunt work in 51 [5] movies from 1930 up to 1965. He was responsible for the B-17 belly-landing for “Twelve O’Clock High” [6] and flew a plane through a billboard for the movie "It’s a Mad, Mad, Mad, Mad World” [7]. Although he was a talented stunt pilot, he specialized in flying through buildings. In the movie “Air Mail” [8], he flew a plane through a 45-foot-wide aircraft hangar. At the beginning he was involved in flying but later his work changed in also being responsible for the recording. In 1950 he was awarded the patent on a camera vibration damping system which was able to record more stabilized movies [9]. The main workhorse of his movie operation was the B-25 camera ship which was used for the movie “How The West Was Won” and "The Final Countdown".

Apart from being a stunt pilot or as he called it:” I’m a precision pilot” [4], he participated in Air Races and before the war he was almost successful in the Bendix Trophy Race. Between 1946 and 1948 Paul Mantz won the Bendix Trophy Race three times consecutively and the only pilot to do so. In 1947 he flew his P-51B Mustang at 460.42 miles per hour from Los Angeles to Cleveland in 4 hours, 26 minutes and 57.4 seconds [10].

In 1954 Charlie Jensen teamed up with Paul Mantz in Los Angeles to conduct pioneering trials in developing a dedicated fire bomber. A Grumman TBM Avenger was fitted with a 600 US gallon water tank constructed from plywood. A weather balloon was used a water container and when the belly doors opened on the TBM it punctured and busted the balloon, releasing the water contents.

In 1961 Mantz merged his business with Frank Tallman into Tallmantz aviation. This was also the time where he would somewhat retire from precision flying and let Frank Tallman take over [3]. However, in 1965 Frank was unable to fly, Paul Mantz stepped in to fly the “Phoenix P-1” for the movie The Flight of the Phoenix. On July 8th while performing a fly by for the camera he was killed. According to NTSB records Paul Mantz accumulated 25100 total flying hours [11].

B. Otto Timm (1893-1978)

Otto Timm was born on October 28, 1893, in Lakefield Minnesota. In 1910 he began his aviation career by attempting to build a copy of the Santos-Dumont "Demoiselle" monoplane. At the time he lived in Milwaukee, Wisconsin. The plane was never finished as getting an engine for it was too expensive. As Otto was interested into aviation he heard that many exhibition aviators made their headquarters in Cicero Field Chicago. At Cicero there were several aircraft being built and that made Otto move nearby. At the airfield tests were performed on these aircraft, which were all unsuccessful. Learning from these failures Otto decided to build a tractor airplane, the pusher Timm, which was based on the Curtis pusher (Curtiss Model D). In 1915 he made his first exhibition flight in Montana at the annual Sidney Street Fair. Following the exhibition flights in Montana, he barnstormed and held exhibitions of flight around the country. Between 1916-1918 Otto was also employed as a flight instructor by the army at Rockwell Field, San Diego California. Otto Timm became the chief engineer for the Lincoln Standard Company in Lincoln, Nebraska in 1921. At this time a large amount of surplus U.S. army two seat basic trainer aircraft, the Standard J, came on the market which were bought by the Lincoln Standard Company. The wood fabric covered bi-planes were remodelled and got a more powerful engine and were sold. The Cruiser, Lincoln-Standard HS model was the redesigned J-1 by Timm. This aircraft was equipped with a 180-horsepower Hispano-Suiza engine and seated 5 [12]. In 1922, Otto went to Glendale California to start the O.W. Timm Aircraft Company. At the time California was the hot spot of aviation developments with multiple companies and opportunities. In 1923 he filed a patent for a rudder bar having the pedals pivot to maintain a right angle to the feet irrespective of the rudder position [13].

In 1927 Timm built a replica Curtis Pusher registered as N3378 for Albert P. “Al” Wilson, a Hollywood movie stunt pilot. In 1932 at the Nationals Air Races, Wilson was killed when he crashed after being caught in the down-wash of a passing autogyro which was part of a stunt display. In 1935 Timm built another Curtis Pusher replica (Nolan) for Paul Mantz who would be using it in the movie "Men With Wings" [14].

In 1938 the Timm T-840 a twin engine, high wing passenger aircraft was designed and flown. This aircraft was equipped with a tricycle undercarriage and low speed aerodynamic devices, it could be configured to carry between six and ten passengers. In 1939 Otto patented the first tricycle landing gear for transport aircraft [15] and a hydraulic actuator (nose wheel) steering mechanism [16].

During the development of the T-840, experiments were conducted with plastic bonded plywood for aircraft constructions. At the same time other manufactures were also experimenting with plastic-wood. The Fairchild Aircraft Corporation patented the duromold process in 1937. The Duromold plastic plywood process was enhanced by Gene Vidal’s Weldwood and later the Aeromold process developed by the Timm Aircraft Company [17]. The aeromold process consisted out of resin impregnated plywood which was moulded und pressure and heat.

The test conducted by Timm were promising and the plastic bonded plywood were deemed very favourable for small aircraft. Between 1939 and 1941 several single engine monoplane trainer prototypes were design and build by Timm, the S-160, Timm PT-160-K, Timm PT-175-L and Timm PT-220-C. The PT-220 with a few changes would become the "N2T1” trainer aircraft for the United States Navy and nicknamed the “Tiny Timm". The Navy ordered 262 aircraft and delivery started in 1943. The N2T1 used the aeromold to create a smooth wing and tail surfaces. Apart from designing and building his own, the O.W. Timm Aircraft Company did a lot of subcontract work for various major aircraft companies. After the bombing of Pearl Harbour the contracts were increased and the CG-4 assault gliders was also requested to be made in large numbers. These assault gliders would be used to land troops during D-Day [18]].

After the war the company changed its business to conversions, maintenance and repair, mainly for airlines like TWA. The company specialized in returning surplus Douglas C-47 aircraft back into airliner configurations. The company also created a subsidiary, Timm Industries, Inc to manufacture of vending machines such as the Frank-O-Matic and Coca-Cola bottle dispensers. From the 1950’s Otto worked with Tallman to recreate old planes for the movies. During this time he developed a 360 degree aerial camera to be installed in a gun turret. In 1965 Timm was contacted by the Tallmantz Company to design a plane for the movie “The Flight of the Phoenix”. The aircraft woould be named the Tallmantz P-1 Phoenix.

C. Frank Tallman (1919-1978)

On April 17th, 1919 Frank Gifford Tallman III was born in Orange, New Jersey. His father was a service pilot who flew in World War I. In 1924 he took his first flight on his father lap. As a teenager he took flight training and was an accomplished pilot before World War II. Frank was a civilian instructor for the Army Air Force before becoming a Navy aviator. He was able to become a Naval Aviation as the college requirements were relaxed. At the end of the war he was part of a Dauntless squadron. After the war ended Frank became a collector of pre-1920 aircraft. He operated these aircraft from Glenview, Illinois where he continued as a Navy Reserve Commander. In 1959 Frank moved to Southern California and based his company at Flabob airport. At this time he had a fleet of sixteen antique aircraft. These aircraft, which were all airworthy, were used in air shows around the US. Occasionally Frank did some TV or movie stunt work but his main work was on flying air shows. Coincidentally he was not far away from Paul Mantz operation and in In December 1961 Mantz and Tallman merged into Tallmantz Aviation. From this point Tallmantz Aviation was involved in several major movie projects. In 1965 Frank Tallman badly injured his left leg in a go-kart accident. As this time Frank was unable to fly, Paul Mantz stepped in and fly the Tallmantz P-1 for the movie The Flight of the Phoenix. The injury of Frank led to severe complications [19] and the doctors had to amputate his left leg above the knee. A long process of rehabilitation followed, with him learning to walk with an artificial leg. After the recovery process Frank Tallman keen to fly again re-qualify for all his FAA pilot certificates. As he was able to fly again and worked on many movies.

On April 15th 1978 Frank flew from Santa Monica to Phoenix Arizona on a routine flight with his Piper Aztec. During this flight he encountered clouds of rain which he tried to fly through. This manoeuvre made him crash into the side of a 3500-foot mountain ridge and died as a result. The NTSB investigation determined that the pilot continued VFR flight into adverse weather conditions. Additional factors cited were the weather and the fact that no records of a weather briefing was received by the pilot before the flight [20].

Model	North American T-6 Texan	Beech C-45 Expeditor	Tallmantz P-1
Length	29 feet	31 feet 3 inches	42 feet?
Wing span	42 feet	47 feet 8 inches	??
Height	13 feet	9 feet 9 inches	??
Empty weight	4,158 lb	5420 lb	?

III. The Aircraft

This section will focus on the aircraft which was developed for the movie The Flight of the Phoenix. In the 1960 the use of special effects was very limited and following the War a lot of old and obsolete military aircraft was available. As the movie audience was captivated by aircraft stunts the director for the The Flight of the Phoenix chose for authenticity. The film scenario called for a transportation airplane to serve as a donor to create another aircraft. For the Flight of the Phoenix a C-82A Packet was used as the transport aircraft.

Fig. 1 The Fairchild C-82 Packet or C-119 (Navy and Marine Corps designation) was an American military transport aircraft which came into service after World War II.

A. Tallmantz P-1

1. Design

The distinct outline of the C-82 limited the design options for Otto Timm as he need to create a 'Flight of the Phoenix' aircraft which should a resemblance the (left) tail-boom of the C-82 with an engine. Due to time constraints and order to keep up with the movie filming and production schedule Otto used a combination of aircraft components. The wings were taken from a Beech C-45. The propeller and the Pratt & Whitney R-1340 engine was taken from a North American T-6. The main fuselage section, the two main landing gear wheels and the cockpit controls were also taken from the T-6. The rear fuselage and tail unit were constructed out of wood with plywood covering. Note that the ventral fin that is part of the C82A is also Incorporated in the Tallmantz P-1.

According to invoice records Otto Timm design and engineering work on the Phoenix was 667 hours at a hourly rate of $ 7.50 [21]. The design work started in March 1965 and was billed up until June 24th. The aircraft was meant to look flimsy as it supposed to be constructed from wreckage. The skids were constructed to look like the landing gear but in fact were hiding the wheels. The aircraft would be used for the movie and paint was used to create the illusion of wear and tear.

2. Certification

On June 1st 1965 the Tallmantz Phoenix P-1 serial #1 with registration number N93082 was given an experimental certificate for exhibition under FAR 21.191(d)[22]. The certificate application shows that the FAA representative found

the aircraft in a condition for safe experimental operation. An experimental certificate allows the exhibiting of an aircraft for a motion picture including (for persons exhibiting aircraft) flying to and from such a production. A condition for the certificate was to have a warning displayed in full view of the pilot that this aircraft is certified as experimental category for the purpose of exhibition. Another condition for the experimental certificate was the condition that flight tests are prohibited.

B. The event

After two initial flights to get familiar with the P-1 performance. The P-1 was transported to the desert location for filming. The intention was to fly early morning on July 8th over a prepared landing area for a touch and go in front of the camera's. Two persons were on-board, Paul Mantz and Bobby Rose. Two passes were made which were filmed by camera's.

Fig. 2 Tallmantz P-1 flying for the Flight of the Phoenix movie sequence [23].

A final third pass was made in which the P-1 touched down on the sand. Bobby Rose escaped from the wreckage with a shoulder injury and Paul Mantz was fatally injured.

Fig. 3 Tallmantz P-1 side view of the tail section separation during 3rd pass in front of the camera's [23].

The crash was filmed by several camera's but of course the footage was not used in the movie. Instead another aircraft, North American O-47A, was used to finish the aerial shots. When you look at the movie Flight of the Phoenix closely the differences can be noted.

C. Accident investigation report

The accident with the Tallmantz P-1 occurred on July 8th 1965 near Winterhaven California. The Civil Aeronautics Board was in charge of investigating air accidents in the United States of America. In 1967 the National Transportation Safety Board (NTSB) was established , taking over air accident investigation duties. As there is an official NTSB reference number to the accident a report was published. Despite best efforts by the authors and NTSB the accident docket or original accident report could not be located. According to available NTSB narrative records the aircraft experienced and in-flight fuselage failure during a low pass for a movie. Two probable causes were determined for the accident. The first cause was determined to be an in-flight overload failure of the fuselage longeron. The second probable cause was the pilot misjudged altitude due to alcoholic impairment [24].

A literature search for additional background information yielded a result in Aviation week & space technology. In this magazine the CAB report was quoted. The following text can be found in the article titled ”Fuselage failure cited in Mantz crash” [25].

A motion picture company, making a movie about the crash of a C-82 twin-engine twin-boom aircraft in the Sahara Desert, contracted with the California aviation company to build and fly N-93082, an experimental aircraft. The aircraft was to represent a plane which the survivors of the crashed C-82 constructed from the wreckage and flew to safety. The filming site was at a desert location 17 mi. west of Winterhaven, Calif., and the aircraft was operated from the Yuma, Ariz., Airport about 19 mi. from the camera site.

About 0530 PST July 8, 1965, the aircraft was preflighted in preparation for the film sequence to depict the takeoff phase of the movie flight, and at 0625, the pilot with a stunt man as passenger, departed Yuma in clear weather.

Plans for the takeoff sequence called for the pilot to make a very low pass over unprepared desert area about 150 ft. north of and parallel to an east-west oriented line of cameras. Piano wire "cats whiskers" attached to the skids were intended to agitate the sandy surface and obscure the fact that the skids were not touching the ground. The desired course was designated by flag markers, and after a short run the pilot was to make a slow and "laborious" climb The pilot said if the wheels actually did touch the ground the would do so only lightly, and if he felt them touch he would begin an immediate takeoff.

The pilot’s first two passes over the flight course were too high, and he flew the third pass at a lower altitude and slower airspeed. As he approached the cameras he was advised the third pass "looked good," and it was continued. Shortly thereafter, the aircraft touched down relatively hard and in a level flight attitude about 200 ft. northeast of the eastern-most camera. After a roll of about 24 ft. the aircraft struck a small rise of soft sand which caused it to bounce about 3 ft. above the ground. At this time the wood-fabricated aft section of the fuselage was observed to separate from the metal forward section at the two top longeron wood-to-steel longeron attachment fittings.

The main wheels touched down a second time shortly thereafter, and the aircraft rolled an additional 117 ft. before it nosed down, cartwheeled one and one-half times and came to rest with the center fuselage section inverted. The pilot was fatally injured and the passenger received serious injuries. Fire did not occur.

Investigation revealed that critical balance and control force problems were encountered during the flight testing of N-93082. The pitch-down tendency was so severe initially that takeoff speed could not be obtained, and pitch-down control forces were so high the pilot could not remove his hand from the control stick during the initial flight. To compensate for these conditions, aerodynamic down loads on the horizontal stabilizer were increased by elevating the stabilizer rear spar 2 1/4 in. and installing 60 lb. of lead ballast inside the fuselage near the tail wheel. The pilot’s control stick was lengthened to increase leverage, and a bungee was installed to lighten the heavy forward stick loads. Also due to aerodynamic problems which caused a damaging hard landing, five life-sized human dummies installed on the upper wing had to be replaced with silhouettes. Following these modifications, the pilot reported that the aircraft flew satisfactorily. He had already decided not to make any flights in the aircraft after nine o’clock in the morning because of the increase in temperature and associated density altitude in the area after that time.

Examination of the right landing gear revealed evidence of the previous hard landing damage. The landing gear was designed with rigid struts and in a manner which transmitted landing loads to the fuselage, essentially undampened. At the time repairs were made after the hard landing, a hard landing inspection was made. This failed to disclose evidence of damage other than that to the right landing gear; however, a photograph of the aircraft after the hard landing incident indicates external paint chipping at the point where the center and aft fuselage are joined.

Examinations by aeronautical and aerospace engineers of the steel-to-wood fuselage longeron fittings, where the failure occurred, showed the design and fabrication of the fittings were in accordance with good aeronautical engineering practice. They concluded that the wood longerons failed in tension due to overloads. The 60-lb. lead weight in the tail section was concluded to have contributed directly to the overload, as did the drag force transmitted to the fuselage by the landing gear when the wheels struck the rise of soft sand. The previous hard landing was considered to have possibly contributed to the failure.

Post-mortem examination of the pilot disclosed a blood alcohol value of 0.13 g/100ml. This value is within the excitement range of alcoholic influence and is considered a sufficient amount to cause impairment of a person’s judgment and physical efficiency.

IV. Analysis

A. Examination Tallmantz P-1 aircraft design

The 3-view drawing that was included with the experimental certification documentation a general layout of the Phoenix is given. However, some measurements do not match with design specifications. As an example, the overall length of the Tallmantz P-1 is given as $42\frac{1}{2}$feet. However, the three chain dimension on the same drawing add up to a total length of 40 feet. According to the FAA certification document the P-1 was equipped with a Hamilton Standard constant speed propeller. It is known and very likely that the propeller and engine (Pratt & Whitney R-1340 Wasp) combination were used from the T-6. The propeller diameter for the T-6 is 9 feet [26]. However, the propeller diameter in the 3-view drawing is shown as 11 feet. Further examination of Tallmantz P-1 photographs before and after the event show a different number of holes in the skids and struts compared to the 3-view drawing. Accident photos also show that the number of holes on the landing brace structure do not correspond with the 3-view drawing. Therefore, the validity of the 3-view drawing in the FAA certification documentation cannot be verified. Assuming that Otto Timm took the C-82 tail boom assembly outline as reference for the P-1 design. He would have tried to create an airplane which, for the camera could resemble the C-82 tail boom. The C-82 tail boom shape is a slender circular section which after the wing narrows to the rudder and tail section. In order to resemble the C-82 the P-1 should have a shoulder wing design. Examining the P-1 empennage section there is a ventral fin. Ventral fins are included to improve directional stability and enhance spin characteristics and recovery. It is unlikely that it would be necessary to increase the vertical tail surface area given the fact there is already a substantial rudder. Furthermore the P-1 was not designed to be a (trainer) aircraft where spins are allowed.

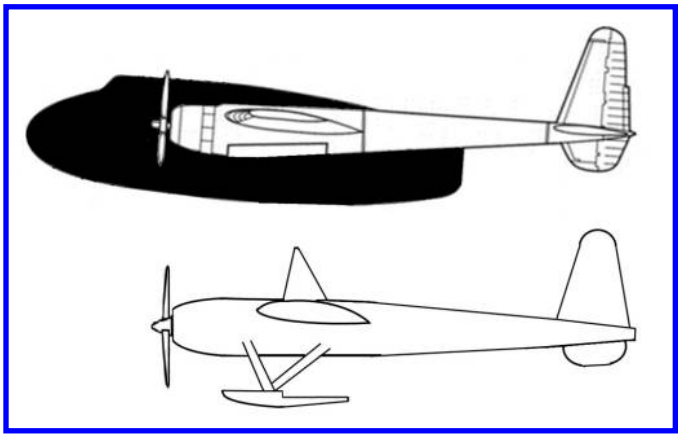

Fig. 4 Top view contour drawing Fairchild C-82 Packet with the left tail-boom in white (left) and the Tallmantz P-1 "the Phoenix" outline (right).

It is know that parts of the Texan T-6 were used as fuselage including the engine. It can be assumed that the engine and its accessories, in front of the firewall, are taken from the T-6 without modifications. Alterations and or redesign would be very labour intensive and not cost effective. The engine dimension should therefore correspond to the T-6. After the firewall the T-6 main fuselage is a truss structure which is connected with bolts. The main fuselage section was in principle taken from the Texan T-6 but needed to be adapted. The Tallmantz P-1 has a shoulder wing configuration, this is unlike the Texan T-6 which has a low wing configuration. Using the connections of the truss structure it would be easy to make a wing to fuselage connection.

For the P-1 the outer wings of the C-45 were chosen. The C-45 outer wing is constructed with a single load carrying front spar and aluminium alloy sheet skin covering. The rear spar transfers the shear load between the upper and lower skin. The airfoil profile is a NACA 23018 at the root to a NACA 23012 at the tip. The wing is 102 inches at the root. The change in wing position has structural design consequences whereby the spar of the wing needs to cross through the cockpit. From photographs its evident that the main spar of the C45 wings were connected through the cockpit.

The C-82 the front fuselage section is 292 inches long and the tail boom assembly is approximately 440 inches long. The T-6 main fuselage section which was used for the Phoenix has an overall dimension of 192 inches. Taking the length of the P-1 front fuselage section and scaling this to the C-82 front fuselage would result in a scaling factor of 0.65 4. In other words the C-82 tail boom outline was scaled by 65% to create the appearance of the Phoenix. This means

that the total length of the Phoenix would result in approximately 40 feet.

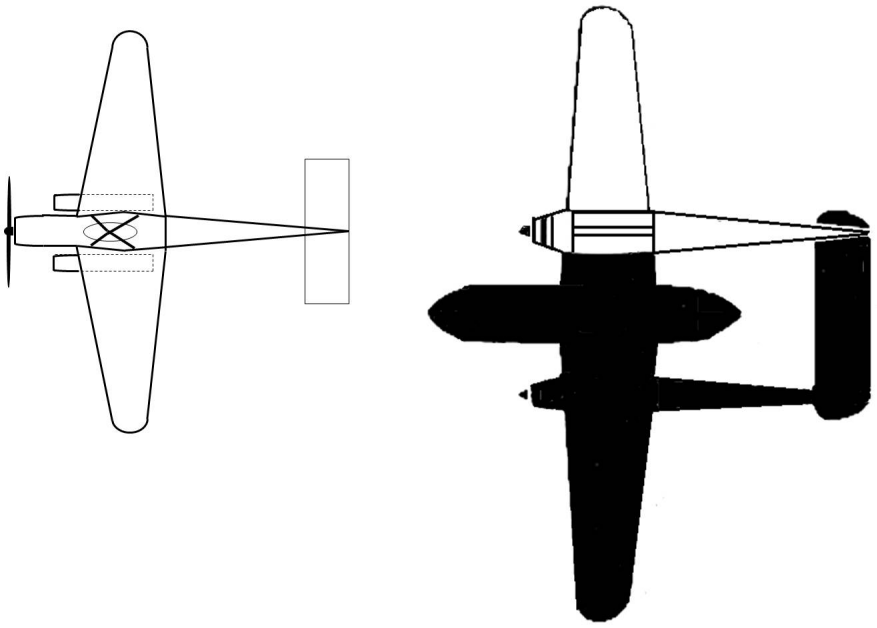

Fig. 5 Contour drawing Fairchild C-82 Packet with the left tail-boom in white (top) and the Tallmantz P-1 "the Phoenix" outline (bottom).

The C-82 has a wingspan of approximately 106 feet, with the outer wing adjacent to the tail boom measuring 35 feet. Assuming the C-82 wings would be connected to the left and right side of the tail boom, which has a 7 feet width, the result would be a wingspan of 77 feet. The C-45 outer wings are 16.5 feet in length. with the T-6 fuselage measuring 5 feet in width a total wingspan of 38 feet would be achieved. This would bring the scaling factor for the top outline to 0.5 which is less then the side outline scaling factor of 0.65, see Figure 5. For the overall design of the Phoenix a wingspan of 50 feet might be more appropriate. However, for the movies it was more important to have a representative side view as appose to the bottom view. Therefore, it can be concluded that the Tallmantz P-1 Phoenix design was made for the movies, it was not designed for any other role.

V. Discussion

The probable cause of the Tallmantz P-1 accident was determined by the NTSB to be an overload failure resulting in an in-flight separation. A second contributing factor was alcohol impairment of efficiency and judgement by the pilot in command. These two probable causes will be discussed in more detail below.

A. Probable factor 1 - overload failure

The Tallmantz P-1 was not certified but was given an experimental certification. A normal certified aircraft will have gone through a rigorous design, testing and evaluation process to evaluate the aircraft performance, strength and handling characteristics for it to be certified as part 23 (AIRWORTHINESS STANDARDS: NORMAL, UTILITY, ACROBATIC, AND COMMUTER CATEGORY AIRPLANES) general aviation. There is no such requirement by the regulator for experimental registered aircraft and no oversight exists for these aircraft. As no flight test can be performed no performance data exists. The Phoenix P-1 does not comply with the International Airworthiness Standard of ICAO Annex 8, Part II. As such the Phoenix P-1 was an experimental aircraft which was allowed, under stringent conditions, to be flown for the motion picture but cannot be considered to be certified similar to a normal general aviation aircraft.

As stated in the accident report there were critical balance and control problems encountered during testing of the aircraft. Records indicate that a total of 3 flight hours on type were flown before the accident[11].After the maiden flight

a 60lb weight was added above the tail wheel to counter the aircraft nose-over tendency. Other changes that were done to the aircraft included moving the stabilizer up and tie a bungee cord to the control stick to alleviate the high control forces. This was the aircraft configuration when the accident occurred.

Using a Class II weight estimation the following can be derived.

Examination of the design and using weight estimations the aircraft weight and balance can be determined. It is evident that the engine which was

the fuselage was a truss structure which was taken from the T-6. The tail was manufactured

B. Probable cause factor 2 - alcohol impairment

The NTSB determined that a contributing factor was alcohol impairment of efficiency or judgement. The NTSB considers alcohol to be a causal factor when a value of 50mg% or higher is found [27]. Studies have shown that pilot performance is degraded even when there is a small amounts of alcohol are consumed [28][29]. The level established by the NTSB for impairment of efficiency or judgement is substantiated.

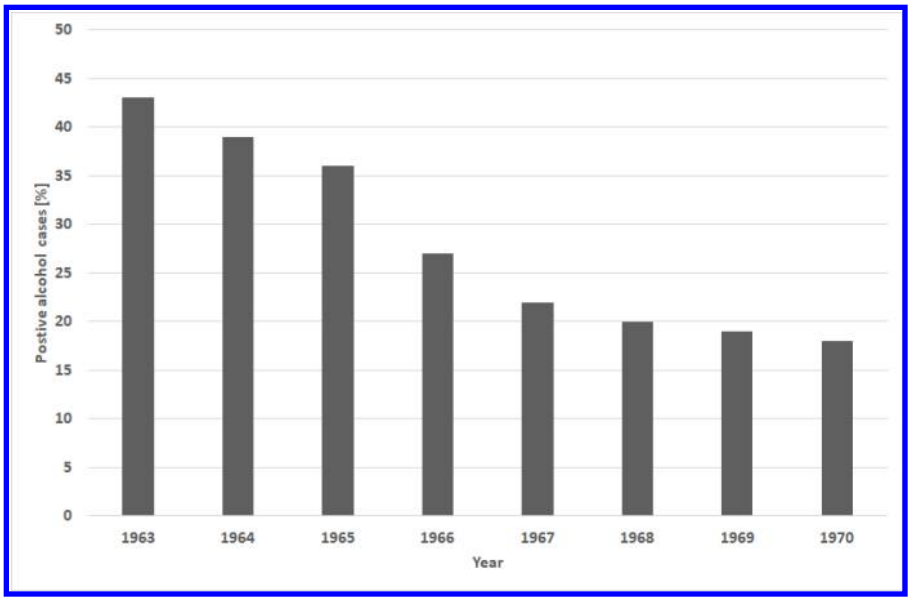

Fig. 6 General Aviation positive alcohol cases [%] [27]

Reviewing the general aviation accidents from 1963-1970 it is evident that alcohol was present in many accidents, see Figure 6. In a 1963 study a total of 35.4% pilots involved in general aviation accidents had measurable level of alcohol in their blood at the time of their crash [30]. This study however did not account for contamination of the blood and putrefication. Subsequent studies which accounted for contamination revealed lower values [31][32][33]. Especially in case of extensive (abdominal) trauma, which is very likely in aviation disasters (e.g. rupture of the viscera), interpretation of blood alcohol values in autopsy specimens from the pilot and crew is highly contentious [34]. In recent studies the main conclusion is that care must be taken to reach a valid conclusion related to blood alcohol levels.

Several sources indicated that Paul Mantz did not drink the evening before the accident flight. This in itself does not reject the hypothesis that alcohol was not a factor, Mantz could have had a drink out of sight. However, taking into account his injuries together with the location and temperature there is a possibility and conditions are present for natural development of blood alcohol. Therefore the blood alcohol level found in Paul Mantz could have been contaminated and the results might be higher as a consequence. Despite this, the blood alcohol value found post-mortem was beyond the NTSB procedural limit. Therefor the NTSB investigation concluded alcohol impairment was a contributing factor.

VI. Conclusion

The Phoenix P-1 was an experimental aircraft which was allowed, under stringent conditions, to be flown for the motion picture titled "Flight of the Phoenix". No test flights were performed for certification, nor were they required to

be performed. Analysis of available drawings dimensions show inconsistencies to reconstructed measurements and aircraft system specifications. The P-1 cannot be considered to be a FAA Part 23 general aviation certified aircraft.

The Tallmantz P-1 was designed to have a specific shape outline which was called for in the movie script. Therefore the P-1 was not designed and produced according to normal engineering design philosophy. The weight and balance, flight characteristics and other aircraft engineering requirements were considered but not optimized in the design due to the outline and time constraints. Different aircraft parts were put together to create a desired aircraft outline and meet the movie schedule.

The accident occurred while a fly by was conducted in front of the camera whereby the P-1 landing skids impacted the ground which resulted in the tail structure being loaded beyond its structural capability.

Testimony and the official accident report show that control problems were encountered during the P-1 development. Changes to the stabilizer location, an added weight in the tail for stability, together with a bungee cord on the control stick brought the P-1 into a controllable condition. The P-1 was not a standard aircraft and as a consequence the flight envelope was not established and aircraft performance was unknown.

A contributing factor to the accident was alcohol impairment of efficiency or judgement of the pilot. The blood alcohol value found post-mortem was beyond the NTSB procedural limit. The current state of art in respect to determining blood alcohol level has changed with new insight and studies on toxicology. It can therefore not be excluded that the blood alcohol level value found was correct.

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