The Missing Wings

A Comparison of actual and expected wing debris resulting from the impact of a Boeing 757 on the Pentagon building (revised Dec 19, 2004)
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Abstract

Detailed analysis of the debris field, physical damage, and other factors in the alleged impact of a Boeing 757 on the Pentagon building on the morning of September 11, 2001 reveals an almost complete absence of debris expected from such an event. (Elliott 2003) The initial (pre-collapse) hole made by the alleged impact on the ground floor of Wedge One of the building is too small to admit an entire Boeing 757. In order to decide whether or not a Boeing 757 (or aircraft of comparable size) struck the Pentagon on the morning in question, a comprehensive review of all the debris and other physical evidence is hardly necessary. It turns out that a study of the wings alone suffices for the purpose.

Wings that should have been sheared off by the impact are entirely absent. There is also substantial evidence of debris from a much smaller jet-powered aircraft inside the building. We conclude with a high degree of certainty that no Boeing 757 struck the building. We also conclude with a substantial degree of certainty that a smaller, single-engined aircraft, roughly the size and shape of an F-16, did, in fact, strike the building.

Introduction

Over the last two years, beginning with the investigations of Thierry Meyssan (Meyssan 2002) and continuing to the present time, there have been numerous claims that American Airlines Flight 77 did not strike the Pentagon building. (Citoyen 2003) (Desmoulins 2003) Although we have arrived at similar conclusions, we do so on the basis of a more focused analysis, one that relies not only on photographs, but on measurements, aerospace archives, and to engineering and physical analysis of the Boeing 757, as well as the structure of the Pentagon walls in the area of the impact.

The analysis is, for the most part, of the simplest type, such as any reasonably bright high school student might follow.

This approach has become necessary in the climate of suspicion that surrounds any attempt to question publicly the claims by major media outlets that Arab hijackers, with one Hani Hanjour in the pilot's seat, brought the aircraft in precisely on target. It is certainly true that Mr. Hanjour failed flying tests, dropped out of flight school twice, and on one occasion, a mere three weeks before the September attacks, was denied permission to rent a Cessna because he showed an almost complete lack of knowledge of aircraft instrumentation to rental personnel (Nat. J. 2003). It does little good to point these facts out publicly, however, because they are only what we call "suspicious circumstances."

In short, a devil's advocate might claim that in the three weeks before his failed rental attempt and the morning of September 11, he somehow acquired the necessary expertise to carry out a high-speed turn and dive worthy of a military pilot. We will show that it makes no difference whether Hanjour was an expert pilot or not. There are direct physical contradictions between the claims of the Bush White House, as echoed by the major media, and the facts on the ground. These contradictions are outside the control of the media, Mr Hanjour, or the authors, for that matter.

The analysis presented here is based entirely on standard and/or official sources, such as the engineering report issued under the auspices of the American Society of Civil Engineers (ASCE), as directed by an army engineering officer as chair. (ASCE 2003) That particular document details the damage to support columns inside the building, as well as providing an accurate track for the incoming aircraft, as revealed by the penetration of a presumed engine core to the rear of the inner ring. It was not within the mandate of the inquiry to determine what aircraft struck the Pentagon, but rather to evaluate how well the building withstood the impact, fire, and subsequent collapse of a section of the building.

Our general approach to the analysis that follows is to assume, whenever a range of options presents itself, that the White House version of events on September 11 is the correct one. For example, in determining the alignment of the incoming Boeing 757 engines with the support columns of the Pentagon, we have arranged the aircraft so that the engines were most likely to miss the columns that remained standing after the impact, in spite of the fact that a) this particular alignment was rather unlikely and b) the engines would probably have taken out both columns, even with this alignment.

In the first section below, we list all the relevant dimensions for three types of aircraft, as well as the walls of the Pentagon building. In the second section, we bring these elements together in a relatively simple analysis that uses basic principles and methods of physics and engineering that leave little doubt about the conclusions reached here.

At the very end of this article, we construct a mini-scenario that is consistent with both eyewitness reports and the conclusions reached in the analysis.

Measurements and Dimensions

Two types of numerical data appear below. Manufacturer's data may be considered as accurate to within the last digit that appears in a dimension. For example, if the Boeing company gives the wingspan of the Boeing 757 as 127 feet, we assume that the measurement is accurate to the nearest 6 inches, that being the midway point between one length given in feet and the one next higher or lower. Measurements acquired from photographs use simple scaling to provide estimates of dimensions (measurements, in effect) that carry an inherent error that is comparable to error term as it applies to manufacturer's data.

Although we shall work primarily in meters, the international units used by all scientists, we shall constantly provide equivalent dimensions in feet and, where relevant, inches.

The Boeing 757 used by American Airlines Flight 77 was the 757-223 model. The relevant dimensions follow. Dimensions with the word "derived" following them were obtained from engineering drawings and a straightforward scaling technique.

Relevant dimensions of Pentagon (Infoplease, 2003)

height of building: 23.6 m (77′ 3″)
inter-window distance: 3.1 m (10′ 2″) (derived)

inter-column distance: 3.1 m (10′ 2″) (derived)

Relevant dimensions of Boeing 757-200 (Flugzeugtriebwerke 2003)

wingspan: 38.1 m (125′)
inter-engine span:
center-to-centre: 16.3 m (49′ 11″) (derived)
outside span: 18.5 m (60′ 8″) (derived)
max. diameter of fuselage: 3.6 m (12′ 4″)
max. height of fuselage: 4.0 m (13′ 2″)

Relevant dimensions of McDonnell-Douglas F-16

wingspan: 32 ft. 10 in.
Length: 49 ft. 6 in.
Loaded Weight: 13,564 kg (29,896 lbs)

Relevant dimensions of Tomahawk Cruise Missile (Raytheon 2004)

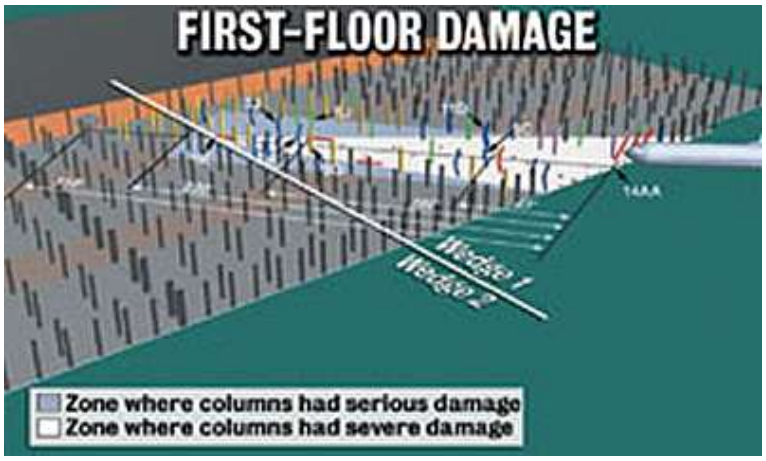
length without booster: 18′ 3″
length with booster: 20’6″
diameter 20.4″

Analysis

Claims that a Boeing 757 struck the Pentagon are difficult to substantiate on the basis of available evidence, primarily a suite of photographs taken by various individuals present at the scene, not to mention images captured by security cameras in operation at the time of the crash. We have, however, made every effort to accommodate the Boeing 757 as the crash vehicle.

The most helpful document in this regard is the report entitled The Pentagon Building Performance Report, issued by the American Society of Civil Engineers. (ASCE 2003). A diagram in that document clearly shows several tiers of support columns on the ground floor of the building (Wedge One) in the area of the impact. Although many columns within the general area remained standing, others were completely taken out by the initial impact or bent to one side, either by the impact or subsequent collapse of the floors above the affected area.

The outermost tier of columns is located just inside the Pentagon wall, a nearly three-foot thick structure of brick, concrete and limestone facing. Between every pair of adjacent windows there is a column behind the wall. Since the inter-window distance is 3.1 m (10′ 2″), so is the intercolumn distance. This dimension was developed by direct measurement from clear photos of the building, using known distances such as the height of the pentagon and simple mathematical scaling. The error term is approximately 5 percent.



9/11 Damage to the Pentagon Diagram from the ACSE Report

In the engineering report, four of the columns are missing altogether, while a fifth column on the right side of the initial hole is bent (outward), but intact. We may therefore take the width of the gap as 5×3.1 = 15.5 m (50′ 10″)

The track of the incoming aircraft, as measured by aligning the entrance hole with the exit hole three rings into the building, is approximately 45 degrees, with an error of three degrees in the calculation. A similar angle is displayed in the engineering report. Although we cannot say what the attitude of the incoming aircraft was, the absence of any impact disturbance anywhere on the Pentagon lawn area makes it clear that no part of the aircraft touched the ground prior to impact. However, if the aircraft came in at a significant angle relative to the horizontal, there should have been a crater or an explosively excavated hole just inside the building. Although the floor area was heavily scarred and burned in places, no such damage was found by persons entering the building after the flames were extinguished by firefighters. We may therefore assume that the incoming aircraft entered the building at nearly level attitude, leaving nearly all of its kinetic energy available for the destruction of interior walls and columns.

Boeing 757 Superimposed on Pentagon Grounds

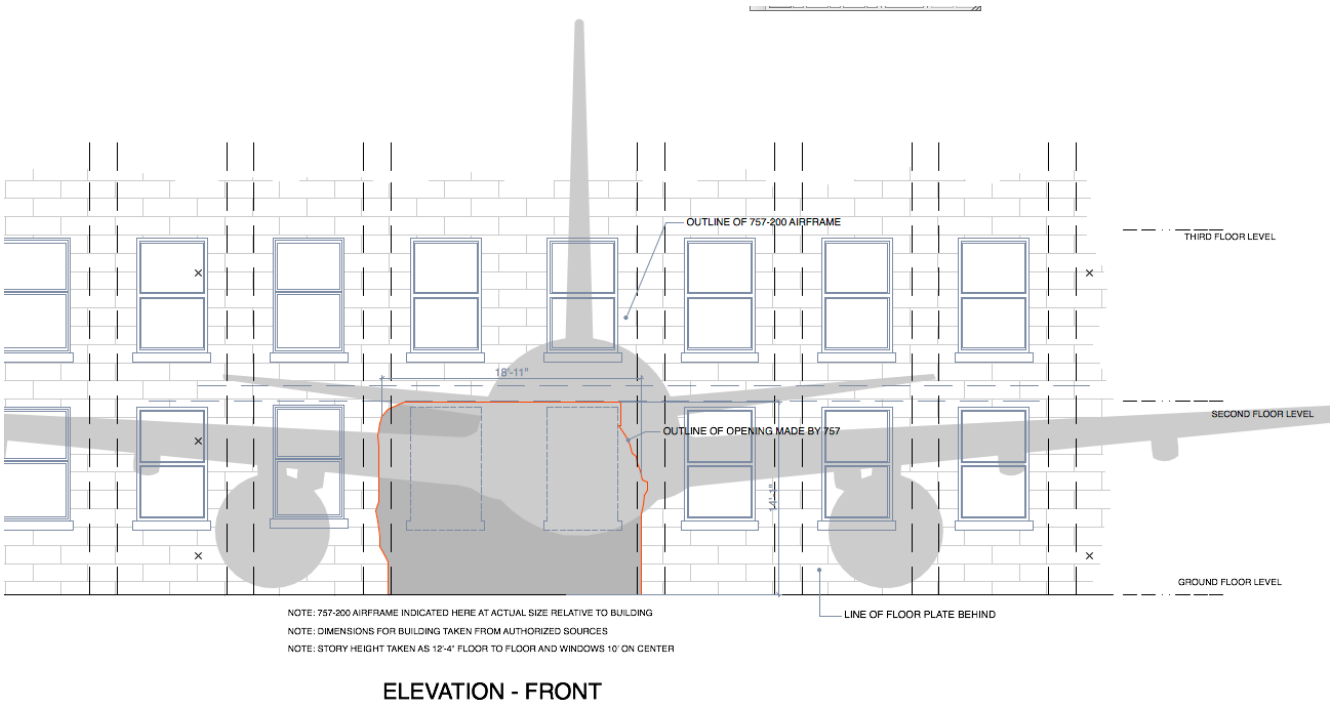
An incoming angle of 45 degrees (horizontally) yields an effective gap width of 15.5xcos(45) = 10.96 m from which we can subtract approximately half a meter to allow for the half-width of the two flanking columns. The effective gap width relative to an aircraft approaching the building at a 45 degree angle would therefore be 10.5 m (34′ 5″)

It can be adopted as a general, commonsense principle that if a large, wide and heavy object, moving at a speed of hundreds of kilometers an hour strikes but does not pass through a physical barrier, it must remain on the side of the barrier it struck. Although, large, heavy objects may be destroyed or damaged by such impacts, neither they nor their debris vanish after such an event.

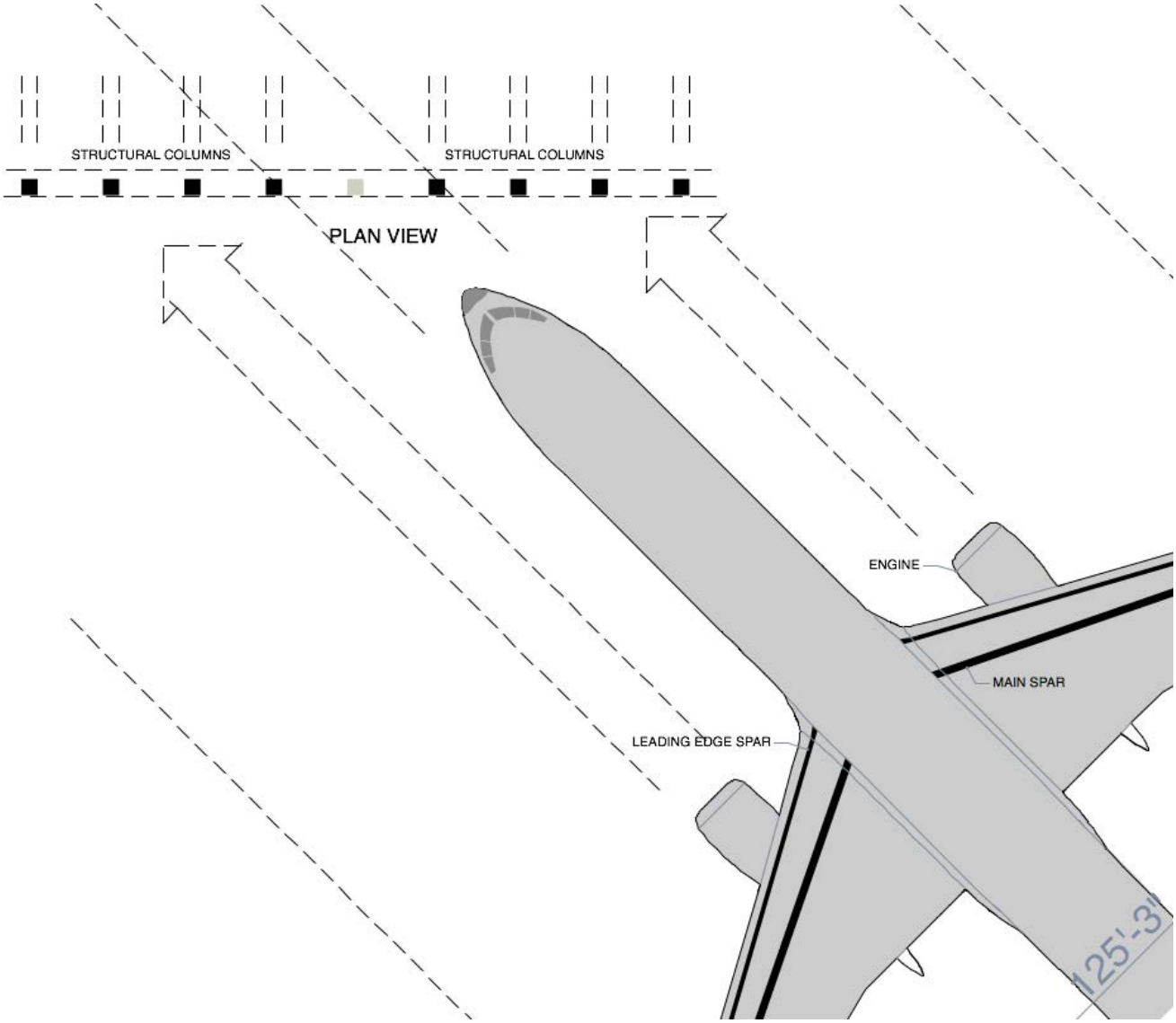
We will concentrate on the wings of the Boeing 757, the dimensions of which can be deduced from the data displayed above. The span-length of each wing is 17.3 m (56′ 7″).

However, the wings of a 757 are swept back at an angle of 29 degrees, as made by the leading edge with a line at right angles to the roll axis of the aircraft. Applying the cosine function to determine the length as measured along the leading edge yields a figure of 19.8 m (64′ 11″).

The figure below shows our reconstruction of the (alleged) approaching aircraft in proximity to the building, with the 5-metre wide fuselage creating a hole that was 15.5 m wide. The discrepancy would be partly due to the 45-degree approach angle and partly to the strength of the wing-roots, which might well be expected to take out a column or two as the aircraft entered the building.



Elevation View showing wings and engines in relation to building structural layout.



Plan View indicating relative positions and sizes/trajectories of engines and wing structure.

As can be seen in the drawing, the engines could only have penetrated the building by being allowed to slip between support columns. This drawing was made before the authors viewed the ASCE engineering report, but it happens to match it rather closely. There would be no way, of course, for the wings to enter the building without taking out any support columns in their path. Structural integrity of the wings, as well as the lack of any holes on either side of the main initial entrance hole, preclude the wings from breaking into eight-foot fragments which then passed into the building individually. In any case, a majority of windows on the ground floor (not to mention all floors above them) remained unbroken after the crash.

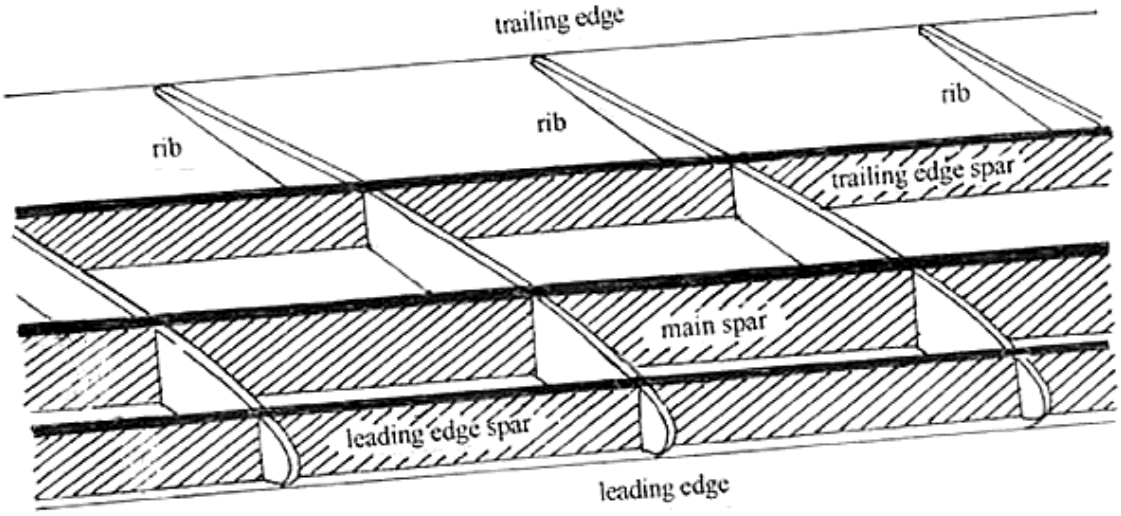
Unbroken windows beside primary hole

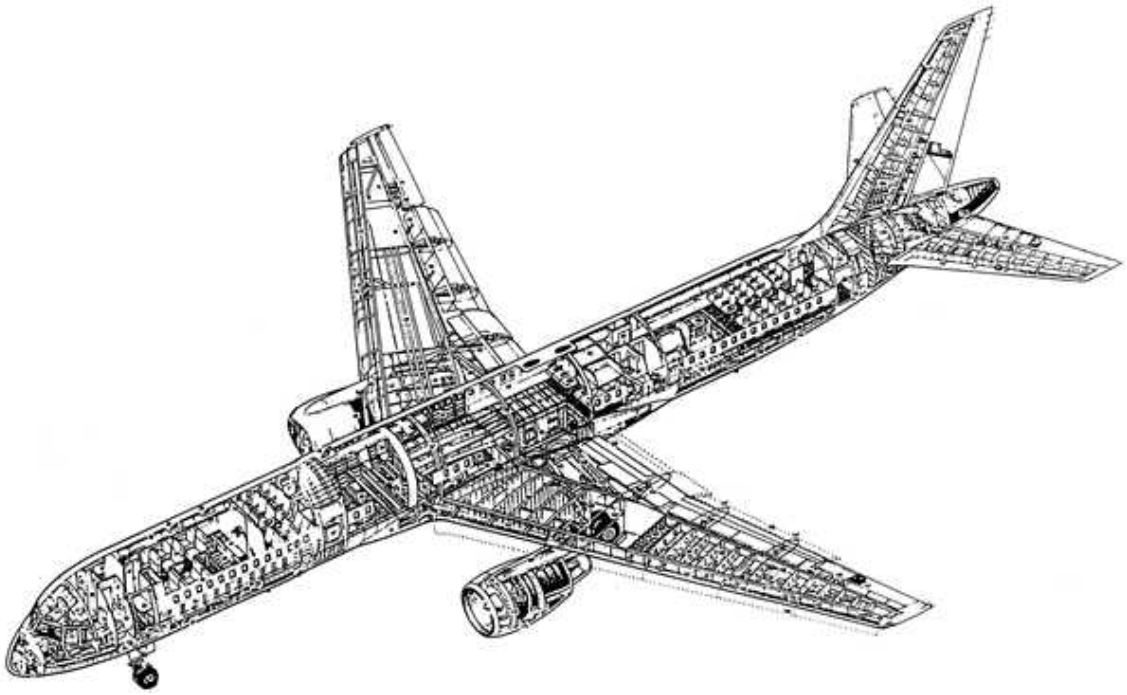
In the image above, taken before a section of the Pentagon above the primary entrance hole collapsed, one can see the left side of the hole, partially obscured by drifting smoke. One can also see unbroken widows on both floors.

According to the principle that we have stated, two wings, each approximately 18-20 m long (however crumpled and damaged) must have appeared in virtually all the photographs taken of the Pentagon damage on the morning of September 11, 2001.

However, there are other reasons why the wings might be absent from the crash scene. Before systematically listing and evaluating such reasons, some information about the wings of a Boeing 757 is in order.

Aircraft wings have two main structural components beneath their aluminum skin. Spars are ultra-rigid metal beams that support a series of ribs that give shape to the wing. The main spar, a piece of solid aluminum alloy, has the same approximate shape as the floor beam of a house, being perhaps 10 cm thick and less than a metre high at the center of the aircraft. The main spar runs out almost to the end of both wings and therefore varies in height with the thickness of the wing. Two other spars, one aft of the leading edge (the forward spar) and one aft of the main spar (the aft spar) complete the main structural support of the wings.





Schematic of wing structure of a Boeing 757 (above)
and structual details of aircraft (below)

The figure above shows a schematic view of a large passenger aircraft wing. Three spars give the wing rigidity and structural strength: a leading edge spar, a main spar, and a trailing edge spar. The main spar of the Boeing 757 can be seen in the lower image, where a cutaway behind the port (lower in diagram) engine clearly reveals the masive main spar.

Here are the possibilities:

1. Could the damaged wings have been carted off by cleanup crews?

The cleanup of the site did not begin until well after the morning hours of the day in question.

2. Could the damaged wings have “telescoped” into the body of the aircraft, as claimed by the Dept. of Defence?

This claim was clearly meant for reporters, whose technical competence, as a general rule, would be unequal to the task of evaluating such a statement. There would have been no significant lateral force acting along either wing axis and there is no possibility of a wing actually entering the fuselage of the aircraft. If you fixed a Boeing 757 firmly to a given piece of ground, then used a team of bulldozers to push the wings into the body, the wings would merely fold up like an accordion or crumple and bend.

3. Could the wings have been entirely fragmented by the explosion of the fuel tanks after the aircraft struck the building?

The fuel tanks of a 757 are located under the fuselage, as well as in the wing roots. The entire fuel storage area of a 757 would easily fit inside the initial entry hole and, consequently, any explosion would have been largely confined to the building’s interior. As we shall see, the wings could not have entered the building, where they might possibly have encountered such a fate. The blast, as such, had little effect outside the building, as cable spools near the entry hole remained standing, for example.

4. This raises the question of whether the wings could have folded as the aircraft entered the building, bending backwards and following the aircraft in.

Except for fuel tanks, wiring and hydraulics, spars and ribs, wings are otherwise hollow. The spars could be

described as locally rigid and globally flexible. In other words, a wing may flex (up and down) along its length when an aircraft encounters turbulence, for example, but, over much shorter distances, cannot bend significantly. Given sufficient force (applied either up or down) against a wing, it will simply break off. Sometimes the wings of older aircraft developed cracked spars. Even hairline cracks can be dangerous, as the slightest shearing force on the wing could widen and deepen the crack, causing catastrophic failure and the loss of a wing.

Of course, the force in question would not have been vertical, but horizontal. This makes the folding even more improbable, as the force of impact would be acting along the only possible fold axis, rather than at right angles to it. Try folding any material, say a piece of cardboard, by applying it's edge (not it's surface) to a tabletop. Folding horizontally is not an option, since all the spars would be lined up in opposing (momentarily) the folding force. Being locally rigid, the spars would simply snap within milliseconds of the impact against a support column that did not yield to their impact; they would fail as soon as the force of impact exceeded the elastic limit of the material. If they did not fail and if the support columns did not give way, the only remaining possibility would be for the aircraft to remain almost entirely outside of the Pentagon.

Only one possibility remains.

5. A devil's advocate might bring up the fire that burned inside the building for approximately seven minutes before being extinguished. Although the colour temperature of the fire appears too bright for kerosene (i.e., jet fuel), we will invoke the White House interpretation of events, as mentioned earlier. Kerosene burns at approximately 860 degrees celsius in ambient air and less in a confined space where the fire tends to use up oxygen. (ASCE 2003)

Fireball From Initial Hole in Pentagon, or secondary explosion?

Could such a fire have destroyed both wings to the point of near invisibility? The simplest answer is that the left wing was exposed to fire only near the wing root, the more distal portions being completely beyond the reach of flames or heat sufficient to melt the aluminum, let alone to burn it. The window frames to the left of the initial hole are all intact, so any heat radiated from the fires in the building would have had to come through the windows to the outside, largely missing any sections of wing that might have been lying outside them.

2. At six meters from the fire, even under direct exposure, the heat would have been insufficient to raise the temperature of the aluminum skin much above 500 C, well below the melting temperature of aluminum, namely 660 C (NASA 2003).

In other words, it would have been a physical impossibility for any portion of the port wing beyond about four meters from the fire to be melted, vaporized or in any way destroyed by it. Thus, at least 16 m (52′ 6″) of that wing ought to have remained (and to have been clearly visible) on the left of the entrance hole. In fact, no such debris appears in any of the pictures taken of the Pentagon that morning.

Absence of Major Wing Debris in Front of Pentagon Wall

Until we hear of a completely different means by which both wings could have disappeared, we must assume that neither a Boeing 757 nor any aircraft of similar size struck the Pentagon on the morning of September 11, 2001. We would be happy to hear from any readers with serious alternative suggestions for how the wings might have disappeared before, during, or after the impact event.

If a Boeing 757 struck the Pentagon in the manner described in the ASCE report, the port wing struck a column just to the left of the presumed engine-hole. Since the column did not fail, the wing must have, Here is why: The aircraft came in at 45 degrees to the wall of Wedge One and the port wing of a Boeing 757 is swept back at an angle of 29 degrees. Thus the angle made by the wing with the support column would have been

45 + 29 = 74 degrees

at the moment of impact. Clearly, no other portion of the wing could have been in contact with the Pentagon wall at that moment and the entire weight of the wing still, traveling at 500-plus miles per hour, would have produced a bending force that was entirely concentrated on the point of contact of the wing with the support column. This would have snapped all three spars instantly. The outboard portion of the wing would then have pivoted into the wall of the building, slamming into it but unable to penetrate it, because now the momentum of the wing, instead of being concentrated at one point, would have been distributed along the length of it contact with the building's wall.

We can declare that this did not happen, since neither the port wing nor any significant portion of it was found outside the Pentagon on the morning of September 11, 2001.

Mini-scenario

A clear and definite distinction must be drawn between two aspects of any forensic or criminal investigation: What did not happen and what did happen. The foregoing analysis shows as clearly as we can state the case, that no Boeing 757 struck the Pentagon that day. In a sense, that's the easy part of the investigation. Finding out what did happen is a necessarily incomplete process, although some parts can be filled in with a high degree of reliability. Scenario construction is an attempt to fit the anomalous and non-anomalous pieces together in a manner not unlike a jigsaw puzzle. Here is a brief foray into the "what did happen" side of the equation.

A possible alternate explanation of what happened on that morning can be pieced together from eyewitness accounts of the tragedy, as well as other sources of information. There were apparently three aircraft involved in

the affair: (Killtown 2003)

1. A military C-130 transport aircraft carrying out strange diving and climbing maneuvers in the area of the Pentagon (restricted airspace) at the time of the crash.

2. A Boeing 757 or 767 painted in American Airlines colors (possibly Flight 77 itself) overflying the Pentagon within seconds of the crash.

3. A military jet, possibly an F-16, which came in low and very fast, straight toward the Pentagon.

If the Pentagon attack was essentially a staged affair, it would be necessary to create as much confusion as possible to distract potential eyewitnesses from seeing the actual attack aircraft or, if seeing it, assuming that it was not the impact vehicle. (pi911 2003)

Thus, the C-130 carrying out strange maneuvers near the Pentagon would have been deployed to keep as many eyes as possible riveted on that aircraft, much as a stage magician frequently uses the trick of focusing the audience's attention in one direction, while he employs sleight-of-hand in another. Under these conditions, it is highly doubtful that any of the motorists traveling the beltway adjacent to the Pentagon would have been looking in the direction of the Pentagon when an aircraft struck the building.

The actual Flight 77 (or a duplicate of it) flies over the Pentagon and on toward Reagan International Airport or, possibly, Hollings Air force Base. By this time, flights would still be coming to the nearest airport all over the United States and no one would remark on such a landing. Several witnesses reported this aircraft, as well.

As Flight 77 (or its duplicate) flies over the Pentagon, a high-speed military jet or, possibly, a cruise missile, comes in low, just clearing the grounds fence and the lawn area, then slamming into the Pentagon at approximately 1000 km/hr. It strikes the Pentagon at roughly a 45-degree angle, taking out four support columns inside the wall and removing or damaging many other columns inside the building

As evidence for this possibility, an image of the vertical tail of a military jet was captured by a Pentagon security camera. (Desmoulins 2003a)

Image of Tail of Unknown Aircraft on Pentagon Security

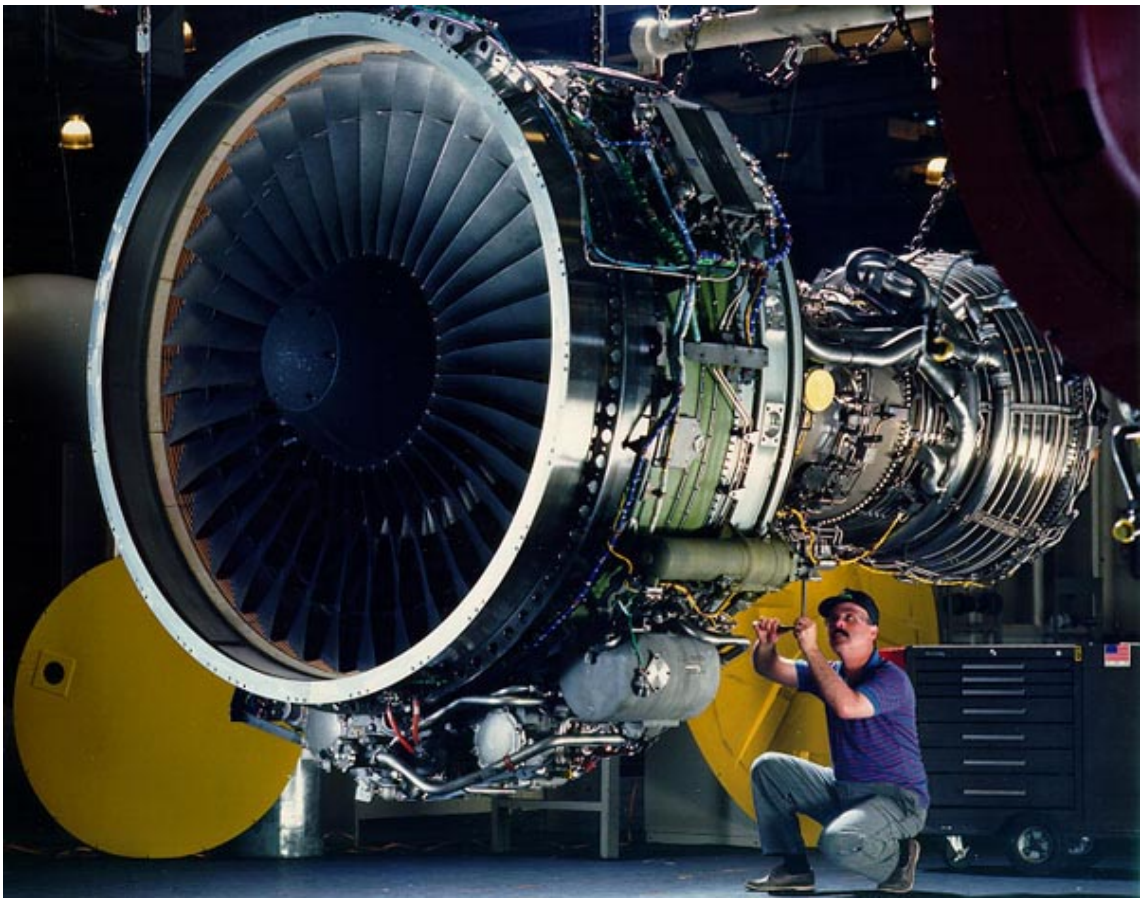
It has been claimed that the stabilizer that appears in this picture belonged to flight 77. In fact, the stabilizer is

too small and fails to bear any trace of American Airlines “AA” company logo.

Only one engine was found inside the Pentagon. The image below shows what appears to be part of the rotor element bearing the stubs of vanes. By comparison with the leg of the worker standing beside it, the part is evidently less than 0.61 metres (two feet) in diameter.

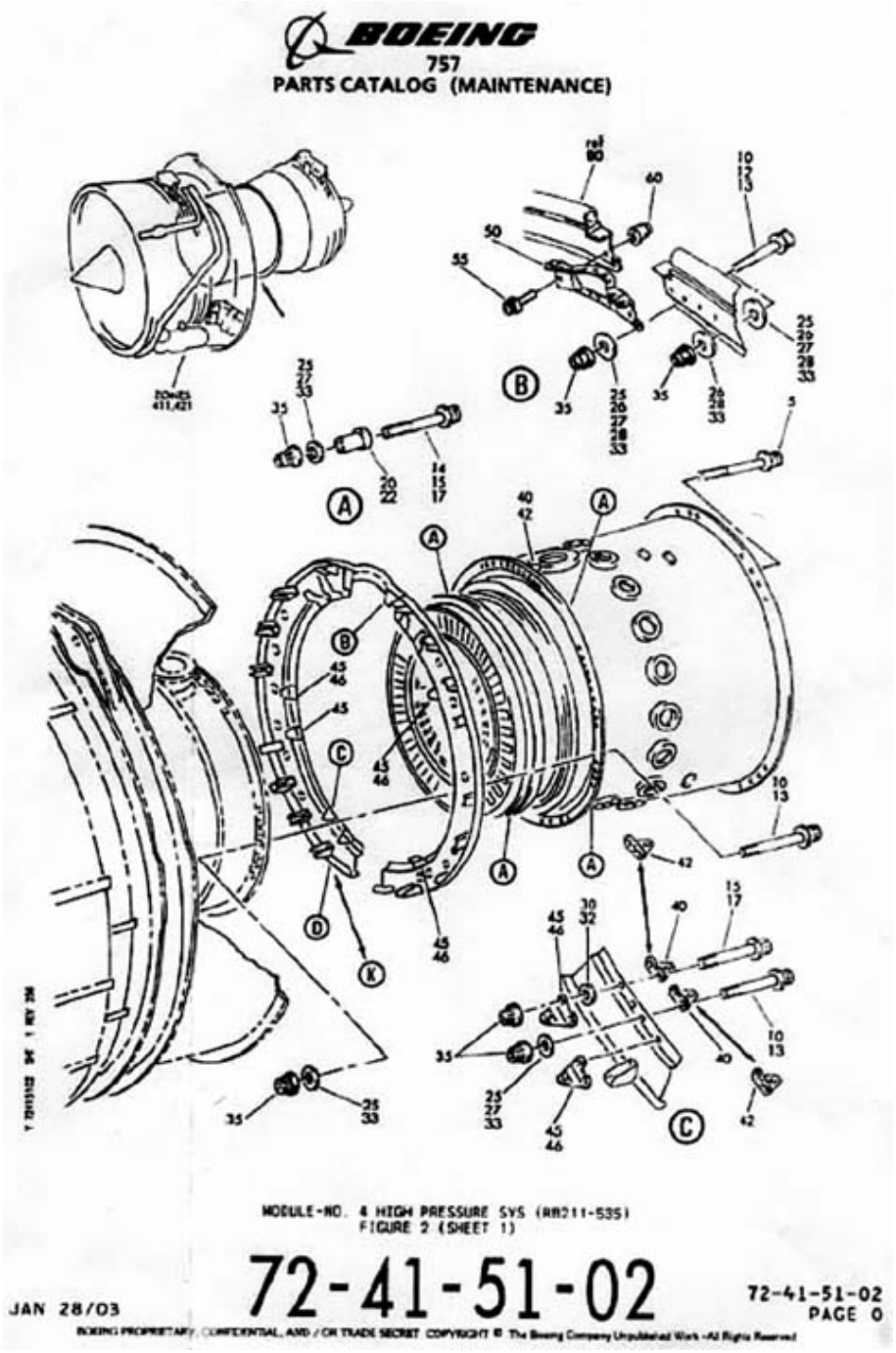
Images of Engine Parts Found in Pentagon

The engines used by the Boeing 757 include the Pratt and Whitney engine shown below (PW 2003), all having the same dimensions, being about 2.5 metres in diameter in the turbofan section and less than half this diameter at the high-pressure (rear) stage.



Turbofan Engine used in Boeing 757

The next image enables us to compare the rotor element with those in the 757 engine shown here. Since the rotor element is dwarfed by the front-stage turbine rotors, we will assume that the rotor is from the rear (high-pressure) stage of the engine, as shown in exploded view in the maintenance diagram below.



Engineering Blowup of 757 Turbofan engine

The front rotor element (inside its housing ring) has a diameter of approximately 1.08 metres (42 inches) with the usual error of at most five percent. If we strip away the vanes, leaving only stubs, the diameter drops to 0.86 metres (2 feet 10 inches). Clearly this part is not from the high-pressure stage of a Boeing 757 engine.

It has been claimed (Catherder 2004) that the part is a rotor from the auxiliary power unit (APU) of a 757. The APU is a small jet turbine engine that supplies power to the 757′s electrical system. The author in question gave no evidence to support the claim beyond providing a link that shows a bump in the rear of a Boeing 757 where the APU exhaust vent can be seen. If the APU lies within this bump, it is probably too small to be the source of this part. A further argument can be made on the basis of the power needed to supply electrical power. The rotor element found at the Pentagon is about the right size for the engine of a military jet like the F-16. It is not clear why such a large engine would be needed to supply power that is only the tiniest fraction of the electrical power that such an engine, suitably harnessed, could generate.

Finally, the 50-foot gap in the support columns of the Pentagon wall easily accommodates the 32-foot wingspan

of an F-16 or an aircraft of similar size. Some have proposed that a cruise missile was employed for the job, but it is difficult to sustain this proposal, given the size of the turbine rotor element. A cruise missile has a 20-inch diameter, which makes it too small to contain a motor with a 24-inch rotor. Given its 9-foot wingspan, a cruise missile is unlikely to take out more than two columns as it enters such a building.

Counterfactual evidence

If the Pentagon attack was essentially a massive deception, it would be very much in the interest of the real perpetrators to sidestep the analysis presented here. Since it cannot be argued against successfully, the perpetrators would be forced to adopt a counterfactual strategy: explain why the crash must have occurred as described. Such an approach would be merely puzzling to anyone who understands this article. If it could not have happened, it did not happen. To someone in the media, however, with eyes glazed over from reading our simple argument, the counterfactual approach would carry telling weight.

In November of 2001, the Armed Forces Institute of Pathology (AFIP) completed a massive study of the DNA of Pentagon victims (Kelly 2001), finding matches between remains and DNA samples allegedly retrieved from victims' homes (gleaned from hairbrushes and other articles of personal use). Although it may well have been the case that matches were expertly made, the weak link in the chain of evidence lies in the collection of samples. DNA technicians would have no way of knowing where all the samples came from. That would be the job of army and FBI personnel that did most of the collecting.

Few people realize how simple it is to obtain tissue samples or body parts clandestinely from morgues, medical school cadaver rooms, any place that dead bodies may be found. Such venues are easily entered by persons who identify the,selves as officials of one kind or another.
A piece of liver or arm tissue complemented by a few hairs, all from the same corpse would be all that's necessary to "identify" a particular person. Would DNA from these different sources match? Of course they would, since they're from the same individual. Hypnotized by the word "match," media types would probably not even realize that "match" does not mean "identify," unless there were independent verification of the source of the samples.

Other problems with the DNA identification process involve contradictions with other claims made by the White House and/or Pentagon about the attack. One claim, that the aircraft was "completely vaporized" makes it doubtful that any of the DNA survived the holocaust. Another claim, that the aircraft was blown into little bits by the initial explosion, would imply that body parts would have been scattered all over the Pentagon grounds – which they weren't.

Given the poor track record of the US government and military in providing accurate information about its military and "antiterrorism" activities, any counterfactual claims must be taken with a large grain of salt.

Summary

The main burden of this article has been to demonstrate that the debris found outside the Pentagon is inconsistent with the impact of a Boeing 757 or any aircraft of comparable dimensions. In particular, in the absence of some agency (possibly unknown to physical science) that removed the wings, there is no way to avoid the conclusion that the wings (and therefore the aircraft) were never present in the first place. In this case, no Boeing 757 struck the Pentagon building on the morning of September 11, 2001.

We have also presented a scenario that may be much closer to the truth of what happened on the morning in question, but our main conclusion is reached quite independently of the scenario and neither implies it, nor is implied by it.

Note

We are aware of another study of the Pentagon crash by scientists at Purdue University. (Sozen 2002) One of us (Dewdney) has designed scientific simulation programs and has taught the subject for many years. A simulation program invariably involves a model of the phenomenon being simulated and the simulation is never better than the model. The Purdue simulation modeled the wings of the 757 as essentially kerosene-filled aluminum bags, in essence, with little structural strength. The wings break into sections when the plane strikes the building, each

section passing between columns and spewing fuel into the growing conflagration. The rudder and tailplane pass into the building unscathed, as well.

The main problems with this model is the complete failure to take into account the structural integrity of the wing as well as the fact that fuel is stored only in tanks in the wing root, adjacent to the fuselage. As for the tail section being completely undamaged, no comment is necessary.

A home experiment

One of the authors made a simple home experiment to determine for himself just what the burning properties of kerosene might be. Here are the steps of the experiment:

1. Prepare a wheelbarrow (or other wide container made of steel) by removing all debris and cleaning the interior surface of all residue.

2. Pour in enough kerosene to cover the bottom of the container to a depth of one centimeter or slightly less.

3. Add a crumpled ball of aluminum foil, an empty pop or beer can, and any pieces of old aluminum you can find, such as lawnmower parts, aluminum door hardware or panels, etc.

4. Set the kerosene ablaze and wait a minute for maximum temperature to be reached.

5. Record which items survived the fire, as well as the degree of damage to each.

What do you observe? (See end of article for answer.)

Acknowledgments

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Results of Home Experiment

If you tried this experiment at home, you may well find the paint burned off the outside of your container. However, the aluminum machine part, the door hardware, the crumpled aluminum foil and, yes, even the pop can will be untouched – except lettering on the can may partially disappear.