**To fly or not to fly?[[1]](#footnote-1)**

Version Fall 2012

Situation sketch

Read to prepare for Monday 9/17 class

The situation to be simulated in the play describes the day of the launch of a new 62 passenger aircraft fully constructed out of carbon nanotube composites at Columbus Airport in 2012. It is the first of its kind and the spectacular result of an extremely fast development program by the newly founded company CACHE (Clarkson Advanced Center for Hybrid Engineering). Thanks to the concerted efforts of parties involved in the field of aerospace technology and the use of their novel nanotube composite technology developed at Clarkson University, CACHE was able to realize this plane in record time and to beat international competition. Today at 16.00 hours the plane is scheduled to take off from airstrip 5 at Columbus in the presence of His Royal Highness, the King of Adirondackland and the prime minister, Rhodes, as well as foreign dignitaries and aerospace officials.

The plane has been stored in hanger Leonardo Da Vinci during the night prior to the launch, but at 4 a.m. in the morning an over-stressed employee of CACHE, embittered by the announced termination of his contract, intentionally drove his fork-lift truck into the junction between the fuselage and the wing. Directly after the accident the driver was overpowered by the guards and taken into custody. The guards had no clear instructions who to warn in this unlikely situation and after some deliberation decided to call the project manager for the launch event, M\_ Crawford, Vice President Development at CACHE, before sealing off the hangar. M\_ Crawford holds a degree in aerospace engineering and was professionally well qualified but had achieved the VP position within the company as a result of a strict and unwavering commitment to deadlines. M\_ Crawford received the call at 04.30 at home in Maple Heights.

M\_ Crawford immediately called the two senior engineers responsible for the final preparation of the plane for its launch, and together they carefully inspected the aircraft and to their great relief found no visible damage apart from the suggestion of a narrow scratch of 15 mm length perpendicular to the leading edge of the wing well outside the reported impact area. Every aerospace engineer knows that the lack of visible damage on the surface of the composite material does not say much about the damage done to the internal structure. Actually the fact that composite material still is not often used in the airplane industry is due to the fact that it is difficult to get unambiguous evidence about the quality and cohesiveness of the internal structure, which is difficult if not impossible to measure.

As the nano-composites are a very new material development there is not as broad an experience in predicting the residual strength after impact as there is for metallic aircraft structures or carbon fiber composite structures. The nanocomposite structures generally behave in a similar way as the carbon fiber composites in that the most severe damage is not at the impacted site but at the opposing rear side, where large scale delamination may occur. The occurrence of rear surface damage depends on the bending stresses during impact and these stresses drop sharply for thicker composite sections. Of course at the site of the impact, the wing root, the composite is rather thick as the forces there can be rather large. Unfortunately, to offer maximum performance and reliability the rear surface of the wing root can not be visually inspected except by totally dismantling and reassembling the wing, which takes about two weeks.

The NDO (non-destructive inspection) technique did not reveal an unambiguous picture of the damage in this case. Due to the damage on the front side, the sound waves were distorted and the absence of any rear surface damage could not be inferred. However, it was also clear that major rear surface damage could not be present. So, there may be damage, but not severe. The precise surface area of the rear surface damage can not be detected and best estimates range from 5 to 25 cm2. These values, as well as some guessed dimensions of the other internal damage, can be used in residual strength calculations. These models are well validated for classical carbon composites and generally hold for carbon nanotube composites too.

After some discussion, which was dominated by M\_ Crawford, it was decided not to report the incident to the authorities as it was felt that this would mean that the launch would be cancelled automatically, nor to inform any other CACHE employees, except the president of CACHE, M\_ Wickham, J.D.. Wickham has no aerospace engineering qualifications but has a background in law and finance. Wickham was appointed president of CACHE for demonstrating great expertise in arranging the financing of CACHE and the development of the plane. Furthermore, Wickham’s political network is exceptional and includes the Prime Minister and the Minister of Economic Affairs (both personal friends), who were involved early on in the plane’s development process.

As M\_ Wickham was taking an early shower, it was not until 06.30 that the contact was made and Wickham was informed about the incident. Being immediately aware of some of the implications, Wickham judged this incident to require more than one persons’ judgment. Deciding to respect the judgment of Crawford and the senior engineers for the time being, Wickham nonetheless calls an emergency meeting of all the management team (MT) members of CACHE to discuss the matter in more detail. The emergency meeting is to take place at 08.00 in the office of Wickham at Columbus Airport. Invited to this meeting are M\_ Lee, director of finance, M\_ Martinez, chief engineer, M\_ Peterson, head of personnel and M\_ Jordan, director of communications, as well as M\_ Crawford, vice president of development. All MT members were approached by Wickham by phone, who informed them about the situation and ordered them to attend the emergency meeting.

Due to unavoidable traffic jams around Columbus Airport both M\_ Martinez and M\_ Peterson do not reach Wickham’s office until 08.10, while the others arrived at the appointed time. Given the urgency of the matter, M\_ Wickham decides to start the discussion at 08.00 sharp, even though not all MT members are present.

1. This activity has been adapted from the original performed at Delft University with permission from Sybrand van der Zwaag and Otto Kroesen. [↑](#footnote-ref-1)