

**Covid-19 and Aerospace Manufacturers:  
The Impact on Airbus and Boeing and  
their Engineers and a Comparative  
Analysis of Airbus' and Boeing's  
Response to this Event Compared with  
Similar Events in the Past**

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# Abstract

The coronavirus pandemic has resulted in a major shutdown in order to reduce how fast the virus spreads through individual populations. The aerospace industry was one among many industries that were severely affected by the measures that were put in place. Airbus and Boeing, being the largest aerospace manufacturing companies, have had to make changes to ensure that the impacts of the pandemic is not as extensive as that from previous global events.

The present report therefore looks at the impact of COVID-19 on Airbus and Boeing and as there have been several events in the past that have affected Airbus and Boeing in a similar way, it was also deemed of interest in this context to compare the current situation with the Great Recession (2008) and the SARS epidemic (2003). A further aim was to investigate how these companies' current responses compare with their responses in the past. Another goal of the work was to examine the human factors effects of COVID-19 on Airbus' and Boeing's engineers.

A mixed quantitative and qualitative approach to the methodology was chosen. The quantitative method involved a descriptive statistical analysis of the effects which COVID-19 has had on Airbus and Boeing compared with those of the Great Recession and SARS on these companies. The qualitative method comprised two types of analysis. The first one consisted in a comparative analysis of a variety of texts, including company websites, research papers and newspaper articles which were searched using selected keywords relating to the methods of recovery used by Airbus and Boeing. The same method was used for comparing this with the methods of recovery following the Great Recession and the SARS epidemic. In order to find out more about the human factors issues faced by Airbus and Boeing engineers a comparative analysis of relevant texts was also conducted as well as a short survey of questions devised.

The results of the quantitative analysis showed that COVID-19 is clearly the worst of the global events that Airbus and Boeing have so far faced. The results of the qualitative analysis showed that the methods of recovery from both Airbus and Boeing include curtailing production and cutting jobs from their sites around the world, which was found to be a common response not only to past events but also to the COVID-19 pandemic. In addition to this, as a response to COVID-19 Airbus has also set up crisis management teams to manage the responses of the company and to ensure that the company is able to recover from the crisis without too much damage. With regard to the human factors issues affecting engineers the results showed that these include constant worries about job security and stress caused by uncertainty of the situation. These issues can have dangerous consequences as these engineers are working in a safety-critical environment where products have to be robust and safe. It is hoped that the comparison of the various methods of recovery from the past with the present, may allow a better response to be formulated in the future when dealing with a similar global event.

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I would also like to thank Kanchan Vanhove, Sally Moore and Julianne Law from the Nuffield Research Programme for giving me an opportunity to experience being part of a research project and for providing as much help as possible even when the programme had to be changed due to the COVID-19 pandemic. The lessons that I have learnt and the skills that I have been able to develop as a result of partaking in this programme are surely going to help me in the future.

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# 1. Introduction

The outbreak of COVID-19 has brought with it a lot of problems for the aerospace industry as the various ways to get around the world on an airplane meant that the virus was able to spread from China to everywhere in the world within a matter of days. Due to the rate at which the virus was spreading around the world, it was decided by a lot of countries to stop inbound and outbound flights. Along with these, the pandemic also brought economic challenges which impacted a lot of companies. The ultimate objective of this research paper is to understand the impact that COVID-19 has had on aerospace manufacturers Airbus and Boeing. In order to put the impact of COVID-19 on the two companies into perspective, this event will be compared to similar events from the past, this project focuses on the SARS epidemic and the Great Recession. It is believed that an investigation of how Airbus and Boeing performed during all these events would give a good idea of what the outbreak of a pandemic has meant for Airbus and Boeing. Additionally, this research project aims to understand some of the human factors issues faced by Airbus and Boeing's engineers during the COVID-19 pandemic.

The problems mentioned above will be discussed using the help of quantitative and qualitative data from the internet, these will be comparatively analysed to see the differences between Airbus and Boeing's individual experiences during the COVID-19 pandemic and also similar events from the past like the SARS epidemic and the Great Recession. A comparative analysis of the impact that events like these have had on Airbus and Boeing while also comparing their responses seems to have never been carried out before. This research could help other companies or organisations understand the effectiveness of the responses that have been made by Airbus or Boeing and in turn this could help them to make better decisions in the future when facing similar challenges. In addition to exploring the impact which COVID-19 and other events have had on Airbus and Boeing, this research project also looks at human factors issues that engineers face. When compared to the amount of work which has been carried out on human factors issues faced by pilots, the work done on the human factors challenges faced by engineers appears to be considerably less. This report therefore aims at contributing to this topic and at helping to understand some of the common problems that engineers face when working in a safety-critical and stressful environment.

Besides this introduction, there are five further sections. Section 2 presents a review of related work on the impact that COVID-19 has had on Airbus and Boeing, the effects of the SARS epidemic and the Great Recession on Airbus and Boeing and also human factors issues that engineers face in the aerospace industry. In Section 3, the methodology chosen for conducting research to collect data and then analysing the data that has been collected is discussed. Section 3 also talks about some challenges that prevent the range of data that this research covers. Section 4 covers the details of the comparative analysis conducted on the data, this is

followed by a discussion section where the detailed analysis of the most important findings of the research. Section 6 then provides the final conclusion to this report and suggests possible future work that could be carried out on this topic.

## 2. Literature Review

“A pandemic is defined as a disease occurring worldwide, or a very wide area” (Kelly 2011: 1), it impacts society in a variety of ways ranging from economic crisis across the world to causing psychological problems for an individual. A pandemic like COVID-19 is capable of impacting the global economy in a multitude of ways. The major impact on the economy comes from the “direct costs of dealing with the outbreak” (Rutherford 2017: 7), which includes hospital, staff and medication. For example, during the Ebola outbreak in 2013, even though this was just an epidemic, the costs of providing hospitals, staff and medication to patients reached USD 6 billion (Rutherford 2017: 7) and this is the same as “3 years of funding for WHO” (Rutherford 2017: 7). This emphasises how much more serious the impact of the current pandemic is and still will be, and how quickly it has caused companies to lose money.

The focus of the present report is on an investigation of the effects that the COVID-19 pandemic has had on the aerospace manufacturing industry. In particular, the focus is on Airbus and Boeing, the two biggest aerospace manufacturers in the world with a revenue of \$101.13bn and \$75.1bn respectively (Mazareanu (a) 2020: 1). Before 2020 and the rise of the coronavirus pandemic, both Airbus and Boeing have been thriving. In 2019, Airbus reported a full-year revenue of 70.478 million euros (Airbus 2019: 1), while Boeing announced a revenue of 76.6 billion dollars, both of which suggest that the companies were quite comfortable during those years (Mazareanu (b) 2020: 1).

As a result of the Coronavirus pandemic, the aerospace industry has been one among many industries which had to curtail production or hours or even had to shut down completely until the lockdown rules were eased in order to help reduce how fast the virus is spreading around the world. Representatives from both Boeing and Airbus have addressed their concerns about the future of both companies. For example, the CEO of Airbus, Guillaume Faury has stated at a press conference that the company “is facing the gravest crisis the industry has ever experienced” (Guessos 2020: 1). Similarly, Boeing’s CEO Dave Calhoun predicts that “it would take around three to five years to properly recover from the pandemic” (Crane 2020: 1). Both these statements suggest that this pandemic is a real threat to the aviation industry as a whole and that there will be grave consequences if the situation is not dealt with properly. The CEOs’ predictions for the future are also supported by a comparison of Boeing and Airbus’ revenues over the first three months of 2020. While Airbus made a profit of £36.5mn last year and Boeing’s amounted to \$2.3bn the destruction caused by the pandemic is evident when looking at the revenue of both these companies over the last three<sup>1</sup> months, Boeing with a loss of \$1.5bn and Airbus with a loss of \$413mn. (BBC News 2020: 1). In view of what has so far been

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<sup>1</sup> The months referred to are January, February and March 2020

published about the impact of the pandemic on Airbus and Boeing, this report will conduct a comparative analysis of the effects of COVID-19 on Airbus and Boeing with the aim of providing a useful overview as well as to give insight into the methods of recovery used by both companies.

As has already been mentioned, the pandemic has hit the aviation industry hard but the people who are affected by this the most are the employees at various companies around the globe. As the CEO of Airbus, Faury, mentioned, some employees had to be let go for “cash containment” purposes (Airbus 2020: 1). In total, Airbus and Boeing have said that they need to cut around 15,000 jobs each from all around the world within the next year. Airbus sees this as a “hibernation” (Buyck 2020: 1) period during which they are slowing things down to contain the problem. In addition to cutting jobs at all their sites, Airbus has also set up crisis management teams made up of people with “motivation, mutual confidence, solidarity and complete trust” (Airbus 2020: 1) who are working at their best to resolve problems like managing the workforce and creating effective strategies to save money. In contrast to this, not much information appears to have been published about Boeing’s attempts to improve the situation at their company. It has been reported though that they have been following basic health and safety measures at their sites to control the spread of the virus. The minimal information being given out by Boeing may be interpreted to mean that they are still not too sure about how to approach the situation or perhaps their crisis communication may be lacking in this unprecedented coronavirus situation.

Although the COVID-19 pandemic is not the first pandemic of our modern times, its economic impact on our world has been unprecedented (Council on Foreign Relations 2020: 1). The present report is therefore also interested in understanding the magnitude of the impact that COVID-19 has had on Airbus and Boeing. It is therefore deemed appropriate to compare the current pandemic with similar global events from the past. There are a few events that have threatened the global economy and the aviation industry in similar ways, for example, the 2007-2008 economic crisis, often referred to as the Great Recession, and the SARS epidemic. It is argued that looking at these past events can help to understand how companies have learnt from their previous experiences and adapted in order to prevent a similar amount of human cost and financial damage from being caused in the future. During the Great Recession, both Airbus and Boeing faced a lot of challenges with production as they had to save as much money as possible. Owing to this Airbus cut production for the first time in seven years (Nytimes.com 2008: 1), while Boeing had to delay the construction of their latest B787 Dreamliner (Harris 2008: 1). In 2008, it was reported that Boeing had a revenue of \$60,909 million, however this amounts to a decrease of around \$6,000 million from their revenue in the year 2007 (Macrotrends 2020: 1). In contrast to this, Airbus managed to increase their revenue by 4,132 euros which may be interpreted to mean that they were able to deal with the situation somewhat better than Boeing and that the measures that they put into place were more efficient in terms of saving money (EADS 2008: 6). Just like in the present coronavirus situation many people were made redundant at the time by the aerospace companies in order to save money. “Boeing had given pink slips to around 1,150 employees in just November 2008” (Forbes 2008:1), however,



as we have seen, this pales in comparison to the number of jobs that have been cut during the present coronavirus pandemic (15,000) in just two to three months. Although there are notable similarities between COVID-19 and the Great Recession, it has to be borne in mind that these are different types of events with each having its own implications. The Great Recession was an economic crisis whereas COVID-19 is a pandemic that threatens the lives of many. Many different sectors in aviation are affected differently by each of these events and this should be taken into consideration when comparing the two. The comparative analysis in this report therefore serves to highlight the magnitude of the coronavirus pandemic on Airbus and Boeing.

There have been many pandemics and epidemics in the past, but the SARS pandemic bears a striking resemblance to COVID-19 as “SARS is an airborne virus that can spread through small droplets of saliva” (WHO 2019: 1). This is similar to COVID-19 because it also spreads through the air in droplets of saliva, which means that both these outbreaks can nevertheless be compared since they are caused by virus diseases that pose similar threats to the world. Before the SARS outbreak in 2003, Boeing reported a healthy annual revenue of “\$54.061 bn” (Boeing 2003: 25) , however by the end of 2003 their revenue had decreased by \$3.576 bn (Boeing 2003: 25). The decrease in revenue suggests that like COVID-19, the SARS epidemic had also impacted the company in a drastic manner. The measures that had to be taken at the time had limited the company from producing as much as they normally would and took a considerable toll on Boeing's revenue. At Airbus, in 2002 the annual report stated a revenue of “29.901 bn euros” (EADS 2003: 2) but unlike Boeing Airbus managed to maintain their revenue over the course of 2003 while the SARS pandemic was developing as the company reported an annual revenue of “30.133 bn euros” (EADS 2003: 2) in 2003. Airbus' performance seems to be better than Boeing's when looking at their financial data. This could suggest that the measures that Airbus administered were better in dealing with the situation than Boeing. Hence, this report will take a detailed look at the responses, i.e. methods of recovery from Airbus and Boeing to the coronavirus pandemic and compare these with their responses made during the Great Recession and the SARS epidemic. One of the major responses that companies like Airbus and Boeing have made while facing a global event like this is the reduction of jobs, which is done with the objective in mind of saving money by reducing their workforce. During the SARS pandemic both Airbus and Boeing also cut jobs from around the world. At the beginning of 2003 Boeing had already recognised that the industry was facing a downturn and as a result of this the company “cut 5,000 jobs in its commercial division” (The Irish Times 2002: 1). In addition to this in June 2003, Boeing “handed out 60-day layoff notices to 845 employees” (Los Angeles Times 2003: 1). While Boeing made large job cuts, Airbus made smaller changes to their workforce by “making smaller job cuts” (Financial Express 2002: 1) and this meant that they were still able to build around “300 aircrafts”(Financial Express 2002: 1) in 2003. Coming out of 2003, in their respective financial reports both Airbus and Boeing agreed that 2003 was a tough year, however they seemed to be very confident that they dealt with the situation relatively well. In Boeing's annual report, the then CEO, Stonecipher displayed the company's positivity by saying that “despite the longest and deepest slump ever in air travel, we remain bullish on the future of commercial aviation” (Boeing 2003: 5). Airbus also seemed to be optimistic about their future as the company stated that “there are some slightly positive financial signs” (Airbus 2003:

22). This statement is strongly backed up by their yearly revenue data that had been mentioned earlier.

In view of the large number of aerospace manufacturer employees who are in danger of losing their jobs it is vital to look at the psychological impact that this would have on these human beings. Since there are, as far as can be ascertained, considerably fewer publications on human factors issues and engineers than, for example on pilots, the present report investigates in more detail the human factors impact on these engineers. In the present context, human factors can be defined as “the science of people at work, it is primarily concerned with understanding human capabilities and applying this knowledge to the design of equipments” (Arpansa 2017:1), whereby the psychological and engineering expertise would be used to make sure that there is a safe working environment and employees have a lower possibility for making errors. With redundancy notices looming over their heads, the human factors issues could have negative implications on the work quality and ethics of engineers as it is likely that they will not be able to focus entirely on their work due to worries about job security . Boeing has recognised the importance of human factors since the 1970s and as a result they have employed human factors specialists. These are experts which have been tasked with making sure that the engineers and pilots at the company are and remain psychologically healthy in order to produce the best products possible (Satow 1999: 1). There is also some evidence online that suggests that Airbus also deals with the human factors impact on their employees. These factors include the impact of the pandemic on an individual’s “work patterns, travel, isolation, family care and health”, uncertainties about “long term job security” and anxiety to prove themselves in difficult situations to keep their jobs. (CAA 2020: 3) All these factors form a psychological barrier between individuals and the accurate completion of their tasks and it is therefore crucial that engineering companies understand this and therefore provide a lot of support to their employees. In a field like aerospace engineering, psychological distractions like this could cause an employee to make safety-critical errors which could lead to loss of life. This report therefore explores the effects of COVID-19 on aerospace engineers from Airbus and Boeing with a view to providing more detailed information about the human factors issues aerospace engineers are faced with when being threatened with redundancy.

In summary, the literature review has clearly shown that Airbus and Boeing, the two largest aerospace manufacturers, have suffered from severe consequences following the coronavirus pandemic. Since, to the best of my knowledge, there have been no comparative studies of the impact of this on Airbus and Boeing and of their responses to it, and since, as far as can be ascertained, there have been no comparative studies of the impact on Airbus and Boeing during the Great Recession, the SARS epidemic and the current pandemic including their methods of recovery, this report will make the attempt to address these issues. Furthermore, it appears from the relevant literature that a lot less has been written about the human factors issues affecting engineers in contrast to the large amount of literature available on human factors and pilots. Hence, this report will also deal with this aspect.

### 3. Methodology

This section describes the methodology that was used to answer the respective research questions. The methodology consisted of a mixed methodological approach - a quantitative method and two types of qualitative methods. As we have seen in the previous section, the report attempts to answer three research questions, which are listed below.

To understand the impact that COVID-19 has had on the aerospace industry, it seemed that comparing two of the biggest companies in this industry was the best method to use. Both qualitative and quantitative data were deemed useful in conveying information about the impact that COVID-19 has had on Airbus and Boeing.

The true size of the destruction that COVID-19 has caused at Airbus and Boeing can only be understood after comparing this pandemic with similar global events from the past. For this report, it was decided that the Great Recession and the SARS epidemic would make good comparisons for the COVID-19 pandemic as they are both global events that had widespread effects in the aerospace industry, especially on Airbus and Boeing. To compare the effects of the Great Recession and the SARS epidemic with COVID-19, quantitative data were considered to be the appropriate choice as the destruction caused by all of these events is clearly communicated through numbers, especially financial data that shows dramatic changes during these time periods. All the data was taken from the internet as there is a wide variety of websites that have recorded the financial history of companies. For example, the annual reports published by Boeing and Airbus themselves also proved to be very useful in understanding the performance of the company in a certain time period. While collecting quantitative data, it was made certain that the data was accurate and reliable by comparing information from multiple sources, most of the data that was checked in this manner was consistent across different sources and therefore it was deemed to be fit for use in this report. While comparing the impact which COVID-19 has had on Airbus and Boeing to similar events in the past, it seemed appropriate to also compare the measures that were put in place by both companies statistically in order to reduce the extent of the damage that was caused. This would help to understand if both companies have managed to build on the knowledge that they gathered from previous experiences and put better measures in place in the current pandemic to help decrease the damage done. Additionally, the knowledge of the measures that were used in the past and in the present could help to plan better responses to similar events in the future and hopefully avoid similar human cost and avert an extensive loss of money. To find information about the responses of Airbus and Boeing during the Great Recession and the SARS epidemic, it was necessary to collect qualitative data. Qualitative data seemed to be appropriate for this situation because the description of the measures that were put in place could help to communicate the mentality with which Airbus and Boeing approached the situations and whether this approach was effective. News articles on the internet were a perfect

source of information for this section of the report as they give precise information about what was happening during these events and what the companies were planning to do.

**Research question (1a): What is the difference in the effects of the COVID-19 pandemic on Airbus and Boeing?**

The quantitative method involved a descriptive statistical analysis of the effects COVID-19 has had on Airbus and Boeing. The data for the statistical analysis were obtained from a variety of relevant online texts, including texts from company websites, scholarly articles, annual financial reports, newspaper articles and news paper reports. These texts were found using Google and subsequently individually searched using a variety of search words and phrases (e.g. Airbus, Boeing, effects of COVID-19 on Boeing/Airbus, impact of COVID-19 on the aerospace industry, Airbus/Boeing curtail production, and so on). These searches returned documents and websites containing a collection of data about the financial situation of both companies. The information found on all the articles were consistent and this suggested that they were reliable and therefore a suitable selection of sources for this report.

**Research question (1b): What is the difference in the effects of the COVID-19 pandemic on Airbus and Boeing compared with those from the Great Recession and the SARS epidemic?**

The quantitative method involved a descriptive statistical analysis of the effects of COVID-19 has had on Airbus and Boeing compared with those of the Great Recession and the SARS epidemic. The data for the statistical analysis were obtained from a variety of online texts, including texts from company websites, scholarly articles, annual financial reports, newspaper articles and news reports. These texts were found online using Google and subsequently individually using a variety of search words and phrases (e.g. Airbus, Boeing, Airbus/Boeing Great Recession, Airbus/Boeing SARS epidemic, Airbus/Boeing financial crisis 2008, Airbus/Boeing job cuts 2003, Airbus/Boeing revenue 2008, and so on). The data obtained were then analysed using descriptive statistics.

**Research questions (2a): What are the types of responses from Airbus and Boeing to the COVID-19 pandemic?**

In order to answer this question a qualitative comparative textual analysis was carried out. The texts for analysis included a variety of online texts, for example, company websites, scholarly articles, annual financial reports, newspaper articles, and news reports. As with the statistical analysis, the texts were found online using appropriate search words and phrases in Google (e.g. Airbus/Boeing job cuts, Airbus/Boeing reaction, Airbus/Boeing response, Airbus/Boeing struggle, and so on). The searches returned reliable results with news articles and written reports. The information found in each of these articles was also cross-checked to see whether it was consistent. In order to carry out the comparative analysis, the texts were then read and similarities and differences noted.

**Research question (2b): What are the types of responses from Airbus and Boeing to the Great Recession and the SARS epidemic compared with the COVID-19 pandemic?**

The qualitative method used for this question was the same as for Question (2a) except that texts pertaining to Airbus' and Boeing's responses to the Great Recession and the SARS epidemic were also included. As above, any similarities and differences were noted.

**Research question 3: What are the human factors issues faced by engineers working for Airbus and Boeing?**

In order to answer this question two types of qualitative analysis were carried out. The first type concerned a comparative analysis of online texts with a view to identifying any human factor issues affecting Airbus and Boeing engineers. To this end, just like for Research Questions (2a) and (2b), relevant texts were found online using appropriate search words in Google (e.g. Airbus/Boeing engineer stress, Airbus/Boeing engineer sleeping problems, Airbus/Boeing engineering errors, Airbus/Boeing human factors, Airbus/Boeing mental health, and so on). During the analysis any human factor issues were noted as well as any similarities and differences. Furthermore, it was planned to devise an online survey of questions to be completed by the Airbus and Boeing engineers who were on Nuffield's database and for whom a request for participation was sent out. However, only one<sup>2</sup> Airbus engineer responded<sup>3</sup>. The engineer was given a set of questions about their experience during this pandemic. As result of this, the online survey was abandoned but the engineer was sent an email with the questions. The questions that were asked are listed in the Appendix. The answers to these questions were hence only analysed in a qualitative manner and compared with relevant information found online.

The final objective of this report was to analyse critically the measures that were put in place by Airbus and Boeing while having an awareness of what worked and what did not work in similar situations in the past. This analysis made use of all the data, both quantitative and qualitative, that has been gathered. First, the responses (described by qualitative data) were analysed to see the impact that they had. Following this the impact was measured using quantitative data (this includes the number of jobs cut, number of people affected, financial data, and so on). To remind the reader, the comparison of the methods by which Boeing and Airbus have limited the damage caused by a global event was done in the hopes of allowing a better judgement to be made in the future when dealing with a similar event.

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<sup>2</sup> I would like to extend my thanks to the female Airbus engineer who replied and was willing to answer the questions.

<sup>3</sup> The most likely reason for the lack of response could be seen in the fact that it was during the summer holidays.

## 4. Results

This section describes the results from the research that has been conducted. In what follows, the results will be presented according to each research question. To remind the reader of the various research questions, they are listed again below:

**Research question (1a): What is the difference in the effects of the COVID-19 pandemic on Airbus and Boeing?**

**Research question (1b): What is the difference in the effects of the COVID-19 pandemic on Airbus and Boeing compared with those from the Great Recession and the SARS epidemic?**

**Research questions (2a): What are the types of responses from Airbus and Boeing to the COVID-19 pandemic?**

**Research question (2b): What are the types of responses from Airbus and Boeing to the Great Recession and the SARS epidemic compared with the COVID-19 pandemic?**

**Research question 3: What are the human factors issues faced by engineers working for Airbus and Boeing?**

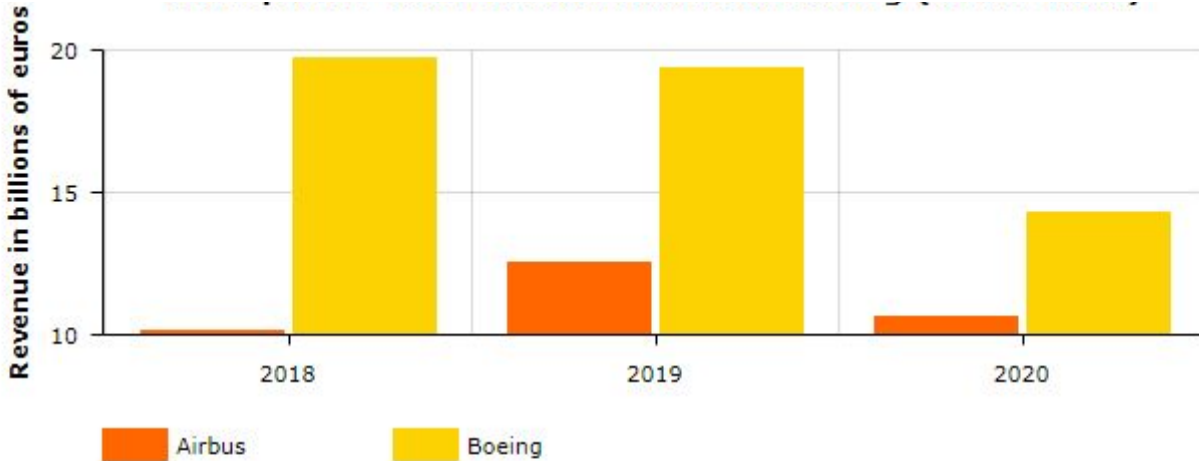
The results have been gained through the various qualitative and quantitative comparative analyses of the relevant literature that has been listed according to the respective research questions in the methodology section. The results include a mixture of quantitative and qualitative data which has been analysed to see how each of the companies performed throughout the duration of a global event.

**Research question 1a: What is the difference in the effects of COVID-19 on Airbus and Boeing?**

The effects of COVID-19 on Airbus and Boeing manifested themselves first and foremost in a decline in revenues and deliveries of aircraft as well as in a loss of stock market values. Below, in Figure 1<sup>4</sup>, the impact of the pandemic on the revenues of Airbus and Boeing during the first quarters of 2018, 2019 and 2020 are depicted. A decrease in revenues for both companies can clearly be seen.

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<sup>4</sup> The data for this graph was collected from the financial statements released by Airbus and Boeing and the graph was drawn using an online application.



**Figure 1:** The first quarter revenues of Airbus and Boeing (2018-2020)

As was discussed in the literature review, namely that the revenues of both Airbus and Boeing decreased dramatically as a result of the outbreak of the pandemic, it can clearly be seen from the graph that Airbus and Boeing have indeed been affected by the onset of the pandemic. For Boeing, there seems to have been a decrease in revenue already as shown in the graph between the years 2018 and 2019, however a larger decrease in revenue can be seen in 2020, quite possibly as a result of COVID-19. Furthermore, Airbus seems to have been recovering from a fall in their revenues as their revenue increased between 2018 and 2019 however their development was halted by the pandemic as their revenue saw yet another decrease.

Table 1 below has been added in order to add more detail to Figure 1 as it provides crucial figures that highlight the impact that COVID-19 has had on Airbus and Boeing.

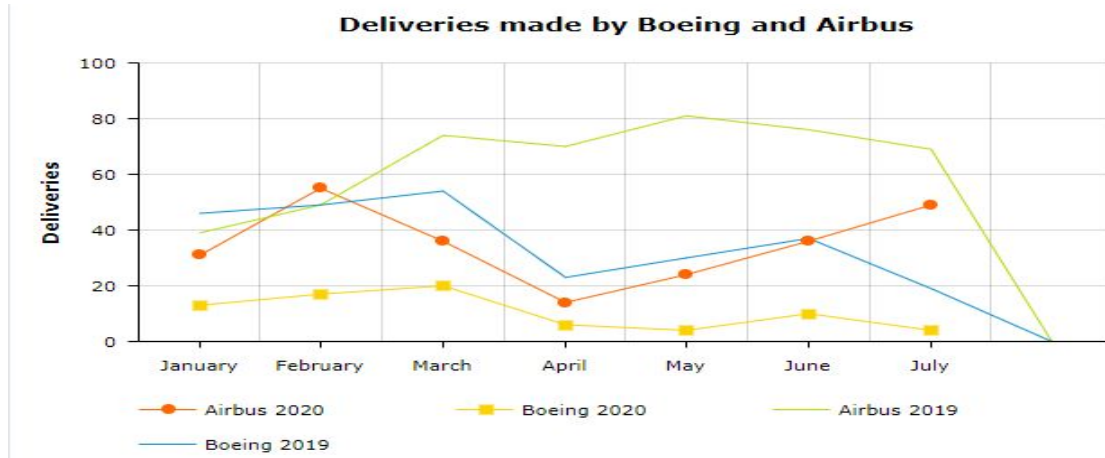
**Table 1:** The comparison of first quarter revenues of Airbus and Boeing over the years 2018-2020

	<b>2018</b> (First quarter revenue in billions of euros)	<b>2019</b> (First quarter revenue in billions of euros)	<b>2020</b> (First quarter revenue in billions of euros)	<b>Percentage change (2018-2019)</b>	<b>Percentage change (2019-2020)</b>
<b>Airbus</b>	10.119	12.549	10.631	+24%	-15%
<b>Boeing</b>	19.745	19.353	14.278	-2%	-26%

Table 1 shows that Boeing's decrease in revenue was almost twice as bad as Airbus' even though Airbus overall has a lower first quarter revenue than Boeing. In addition, Table 1 also clearly depicts the change that COVID-19 has caused in the companies' financial progress through the years, Airbus had a 24% increase in revenue between 2019 and 2018, yet in 2020

had a decrease in revenue of 15%. Boeing's loss of revenue was further worsened by the pandemic as they lost 13 times the revenue in 2020 as they did in 2019.

Figure 2 below displays the deliveries that Airbus and Boeing made through the months of January to July in the years 2019 and 2020. This helps to understand what impact the pandemic has had on the performance of Airbus and Boeing in terms of aircraft delivery.



**Figure 2:** A comparison of the deliveries made by Airbus and Boeing between the months January-July in 2019 and 2020.

The decrease in deliveries made by Airbus and Boeing in 2020 compared to 2019 is clearly displayed in Figure 2. Although both companies were drastically impacted by COVID-19, Airbus seems to be performing better than Boeing in both 2019 and 2020 as Airbus has been making more deliveries compared to Boeing. Furthermore, it can be seen that after both companies had the lowest number of deliveries in April of 2020, Airbus has managed to improve their situation much better and therefore the number of deliveries they have made has grown steadily afterwards while Boeing's still decreased.

Tables 2 and 3 below help to add further detail to Figure 2 as they provide data about the deliveries made by Airbus and Boeing between the months of January and July in 2019 and 2020, these tables can be used to understand what changes the COVID-19 pandemic has caused in the companies delivery statistics.



**Table 2:** Airbus - Number of deliveries made between the months of January and July in 2019 and 2020

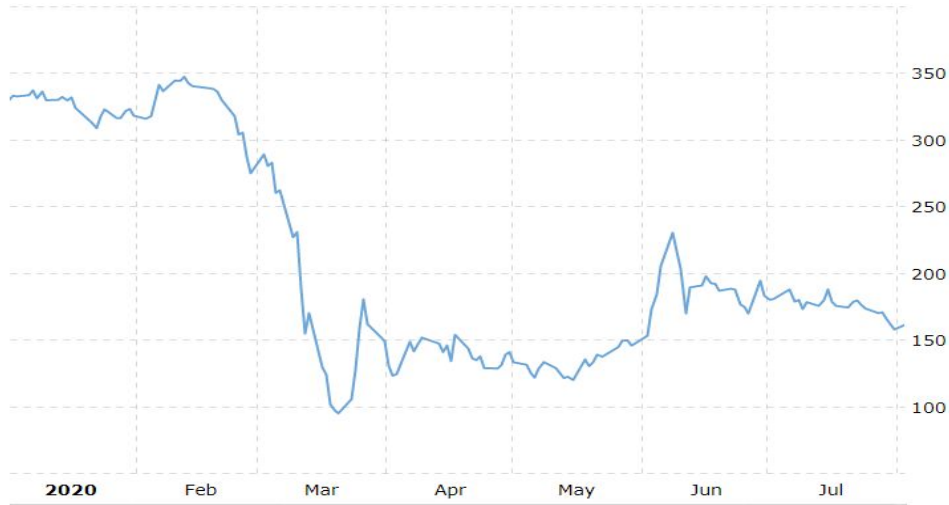
	<b>Total deliveries in January</b>	<b>Total deliveries by July</b>	<b>Change in the total number of deliveries</b>
<b>2019</b>	39	468	+429
<b>2020</b>	31	245	+214

**Table 3:** Boeing - Number of deliveries made between the months of January and July in 2019 and 2020

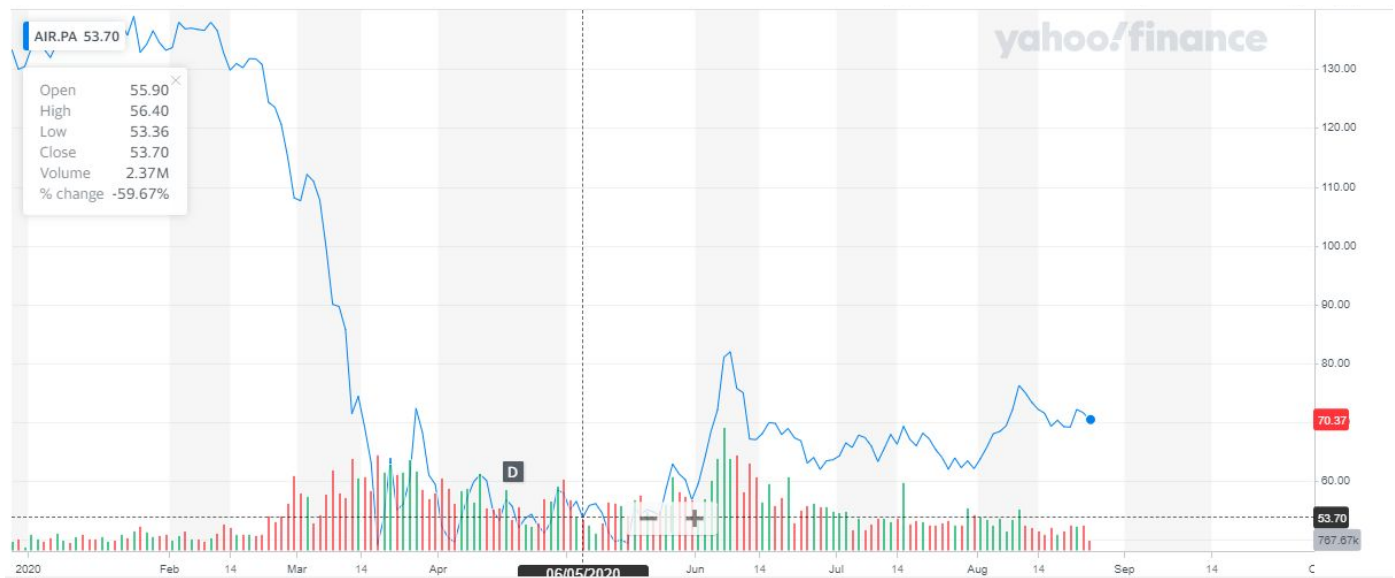
	<b>Total deliveries in January</b>	<b>Total deliveries by July</b>	<b>Percentage change in the total number of deliveries</b>
<b>2019</b>	46	258	+212
<b>2020</b>	13	74	+61

Overall, it can be seen from Tables 2 and 3 that Airbus has been able to make more deliveries in 2020 than 2019, Airbus has managed to make 153 more deliveries than Boeing between the months of January and July while Boeing was only able to deliver 61 planes which is 29% of what they managed to deliver in the same time period in 2019.

In order to understand the economic impact that a pandemic has on companies like Airbus and Boeing, it seemed appropriate to observe the changes in stock market values of both companies. Figure 3 and 4 shows the history of Airbus and Boeing stock market values between January 2020 and July 2020 These months were chosen because after the outbreak of COVID-19 in November 2019, the disease only evolved into a pandemic around January 2020. After the disease was declared a pandemic, the world seems to have changed much more erratically and this caused a lot of issues for aerospace manufacturers Airbus and Boeing.



**Figure 3:** The change in stock market value of Boeing (January-July 2020)  
(Taken from *Macrotrends.net 2020: 1*)



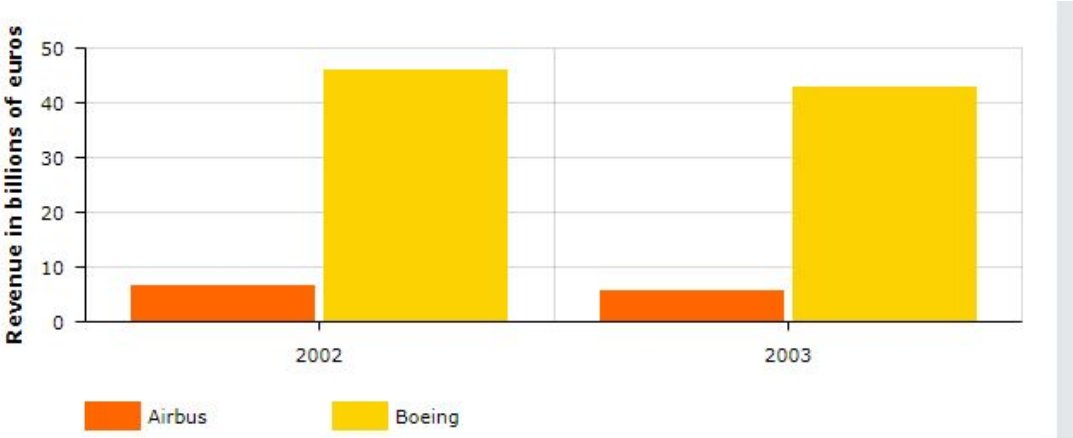
**Figure 4:** The change in stock market value of Airbus (January-July 2020)  
(Taken from *Yahoo Finance 2020: 1*)

As shown in Figures 3 and 4 both Airbus and Boeing stock market values saw a huge fall after February 2020, over this period of time Airbus' stock market value decreased from around 138 to 52 which is a decrease of 62.31%. On the other hand, Boeing's stock market value decreased from around 348 to a low of around 98 in March, a decrease of 71.84%. After this huge fall in stock market values, both companies seem to be recovering well as their value has seen a positive growth since March.

**Research question (1b): What is the difference in the effects of the COVID-19 pandemic on Airbus and Boeing compared with those from the Great Recession and the SARS epidemic?**

**1b.1: Comparing the effect on revenue**

Figure 5 below compares the first quarter revenue of Airbus and Boeing in the years 2002 and 2003, as the outbreak of the SARS epidemic is recorded to have happened in late 2002, it seemed appropriate to compare how the companies were performing well before the outbreak and after the outbreak.



**Figure 5:** The first quarter revenues of Airbus and Boeing (2002-2003)

Figure 5 clearly illustrates that Boeing was generally performing better than Airbus as it was able to earn almost five times as much revenue as Airbus in both 2002 and 2003. However, A clear decrease in revenue of both companies is visible on the graph.

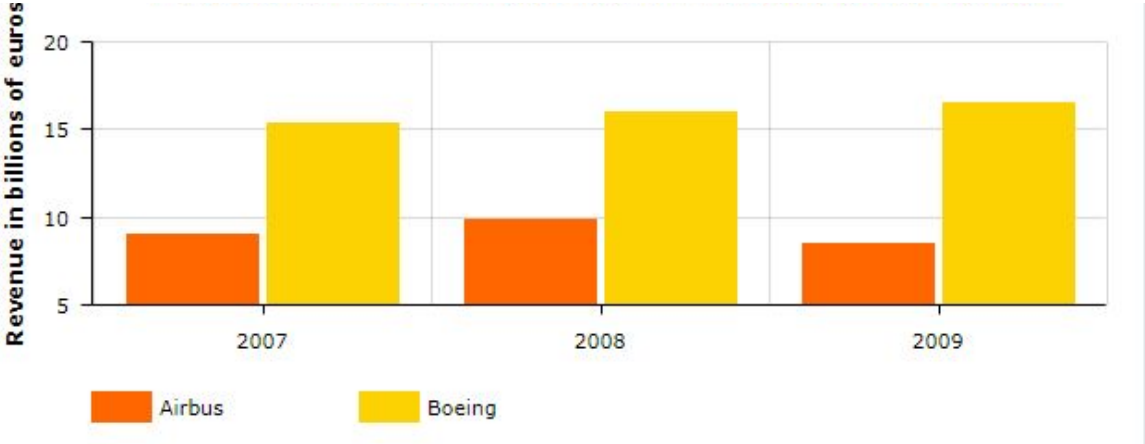
Table 4 below shows the change in first quarter revenues of Airbus and Boeing between the years of 2002 and 2003.

**Table 4:** Comparison of first quarter revenue of Airbus and Boeing between the years 2002 and 2003

	<b>First quarter of 2002</b> (Billion of euros)	<b>First quarter of 2003</b> (Billions of euros)	<b>Percentage change</b>
<b>Airbus</b>	6.41	5.52	-14%
<b>Boeing</b>	45.95	42.91	-6%
<b>Difference</b>	39.54	37.39	8%

From Table 4 it can be interpreted that Boeing performed better during this period of crisis as it was able to do 8% better than Airbus in terms of preventing their revenue from decreasing. Additionally, Boeing seems to have been doing better than Airbus in general even before the SARS epidemic and after the event they continued to perform better than their European counterpart.

Figure 6 displays the changes in the first quarter revenues of Airbus and Boeing through the time of the Great Recession from 2007 to 2008.



**Figure 6:** The revenue of Airbus and Boeing during the Great Recession (2007-2009)

From the graph above it can be seen that Airbus seems to have had a similar experience as they are currently having during the COVID-19 pandemic as a similar pattern is seen in both Figure 6 and Figure 1. While Airbus struggled to continue their growth from the years 2007 and 2008, Boeing showed a constant improvement in performance even through this time of crisis.

**Table 5:** Comparison of first quarter revenue of Airbus and Boeing through the years 2007-2009

	First quarter revenue in 2007 (Billion euros)	First quarter revenue in 2008 (Billion euros)	First quarter revenue in 2009 (Billion euros)	Percentage change (2007-2008)	Percentage change (2008-2009)
<b>Airbus</b>	8.98	9.85	8.47	+9.7%	-14%
<b>Boeing</b>	15.37	15.99	16.50	+4%	+3%

From Table 5, it can be understood that Airbus was successful in increasing their revenue by 9.7% between the years 2007 and 2008, however they were halted by the onset of the economic downturn which is similar to their performance during the COVID-19 pandemic. Although Airbus seemed to have struggled during this period of uncertainty, Boeing managed to increase their revenue over the three years. Even though the increase in revenue by 4% and 3% seems insignificant, they would have certainly helped the company later on.

Table 6 below compares the changes in revenues of Airbus and Boeing during the COVID-19 pandemic with the SARS epidemic and the Great Recession.

**Table 6:** Comparison of the change in first quarter revenue of Airbus and Boeing during COVID-19, SARS and the Great Recession.

	<b>SARS epidemic</b> (2002 - 2003)	<b>Great Recession</b> (2007-2008)	<b>COVID-19</b> (2019-2020)
<b>Airbus</b>	-14%	+9.7%	-15%
<b>Boeing</b>	-6%	+4%	-26%

From this table, it is clear that COVID-19 has brought with it the worst economic downfall for both Airbus and Boeing as both companies seem to have had the worst loss of first quarter revenue during the COVID-19 pandemic. Airbus' loss during the SARS epidemic is the next worst event for the company while Boeing's loss of 26% during the COVID-19 pandemic makes the company's losses during the SARS epidemic and the Great Recession look insignificant.

### 1b.2: Comparing the effect on deliveries

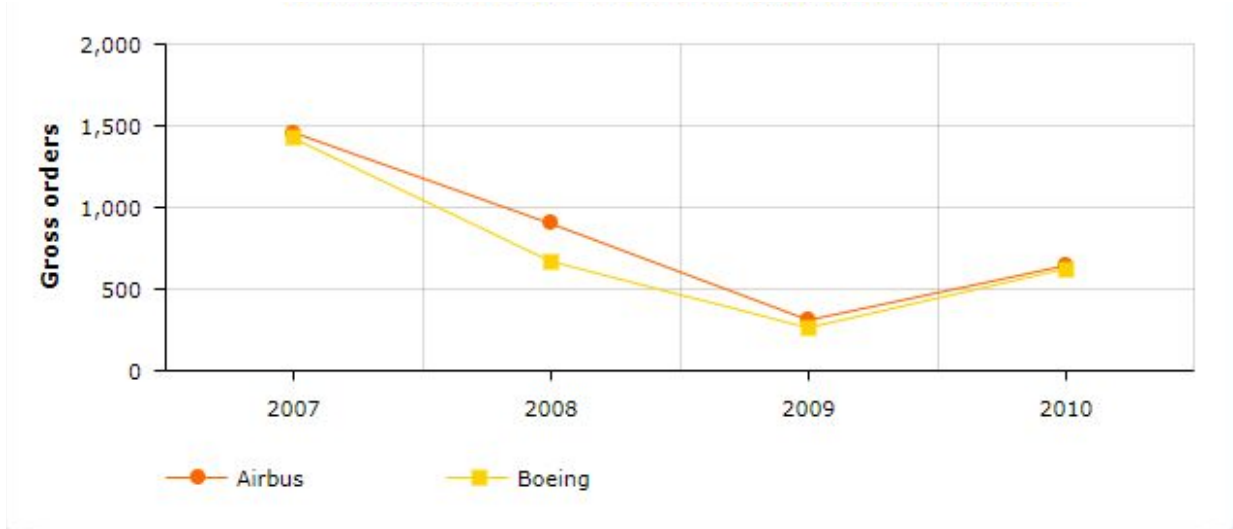
In this section the impact of the SARS epidemic, the Great Recession and the COVID-19 pandemic on Airbus and Boeing's deliveries are compared.

Table 7 below shows the number of deliveries made in 2002 and 2003, the difference in the number of deliveries made between these years is also shown.

**Table 7:** The deliveries made by Airbus and Boeing during the SARS epidemic (2002-2003)

	<b>Deliveries in 2002</b>	<b>Deliveries in 2003</b>	<b>Change</b>
<b>Airbus</b>	303	305	+2
<b>Boeing</b>	381	281	-100

This table clearly highlights the difference in deliveries made by Boeing and Airbus during the SARS epidemic. While Airbus was able to meet its target of 300 which was set for 2003 and even surpassed the number of deliveries made in 2002, Boeing decreased their total number of deliveries by a 100 and so they were only able to deliver 281 planes.



**Figure 7:** The gross deliveries made by Airbus and Boeing during the Great Recession

This line graph clearly portrays the dramatic decrease in deliveries made after the beginning of the Great Recession in 2007. Both Airbus and Boeing saw a drastic decrease in deliveries between the three years (2007-2009), however Airbus seems to have made a higher number of deliveries than Boeing during the Great Recession. After recovering from the economic crisis in 2010, both companies seem to have improved their delivery records.

**Table 8:** Comparison of deliveries made by Airbus and Boeing throughout the time of the Great Recession (2007-2009)

	Gross orders in 2007	Gross orders in 2008	Gross orders in 2009	Change between 2007-2008	Change between 2008-2009
<b>Airbus</b>	1458	900	310	-558	-590
<b>Boeing</b>	1423	669	263	-754	-406

This table further highlights the true size of the impact that the Great Recession had on Airbus and Boeing’s deliveries. Airbus saw a total decrease of 1,148 planes while Boeing saw an even worse decrease of 1,160 planes. .

**Table 9:** Comparison of the change in the total number of deliveries per during the duration of the SARS epidemic and the Great Recession and the first seven months after the outbreak of COVID-19.

	<b>SARS epidemic (2002-2003)</b>	<b>Great Recession (2007-2009)</b>	<b>COVID-19 (Between Jan-Jul 2019 and 2020)</b>
<b>Airbus</b>	+2	-1148	-215
<b>Boeing</b>	-100	-1160	-151

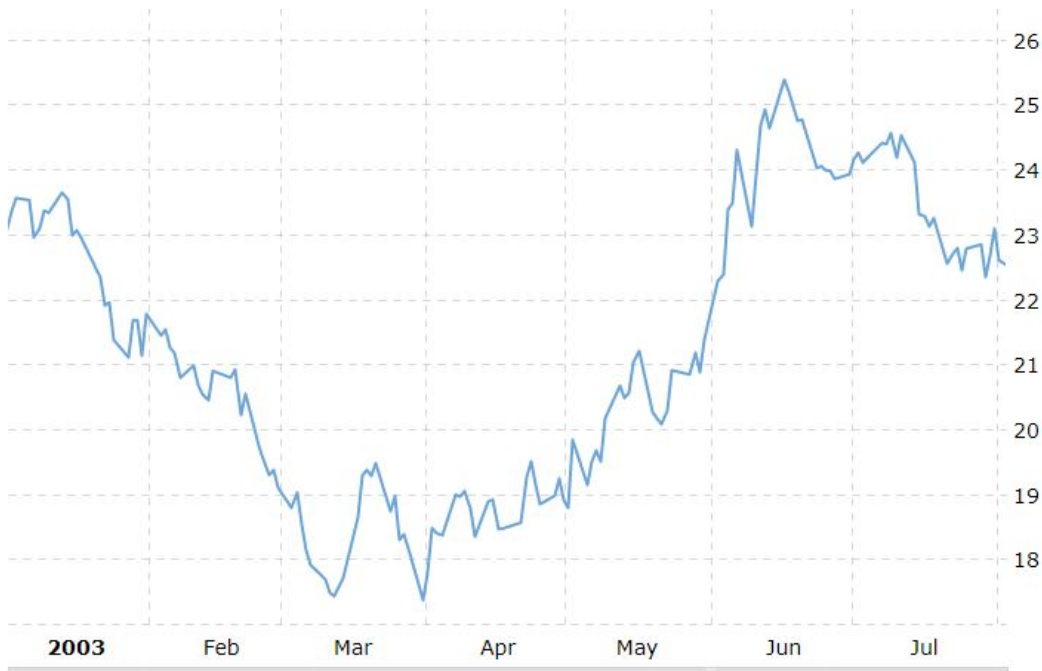
So far into the COVID-19 pandemic, Airbus and Boeing have seen a decrease in the deliveries made, however it could be the case that more deliveries have been made later this year and that they will be able to produce better records by the end of the year. It can be seen that the Great Recession probably has been the worst for both Airbus and Boeing in terms of the deliveries made. This could be attributed to the longer period of time through which this global crisis lasted, although it is predicted, as we have seen, that the effects of the current pandemic will last for longer than those of the Great Recession.

**1b.3: Comparing stock market values**

Figures 8 and 9 below display the change in stock market value of Airbus and Boeing through the first seven months of 2003, studying the trends in stock market values could help to understand what kind of economic changes an epidemic like SARS brings to companies like these.



**Figure 8:** Changes in stock market value of Airbus during the months of January-July in 2003. (Taken from Yahoo finance 2020: 1)



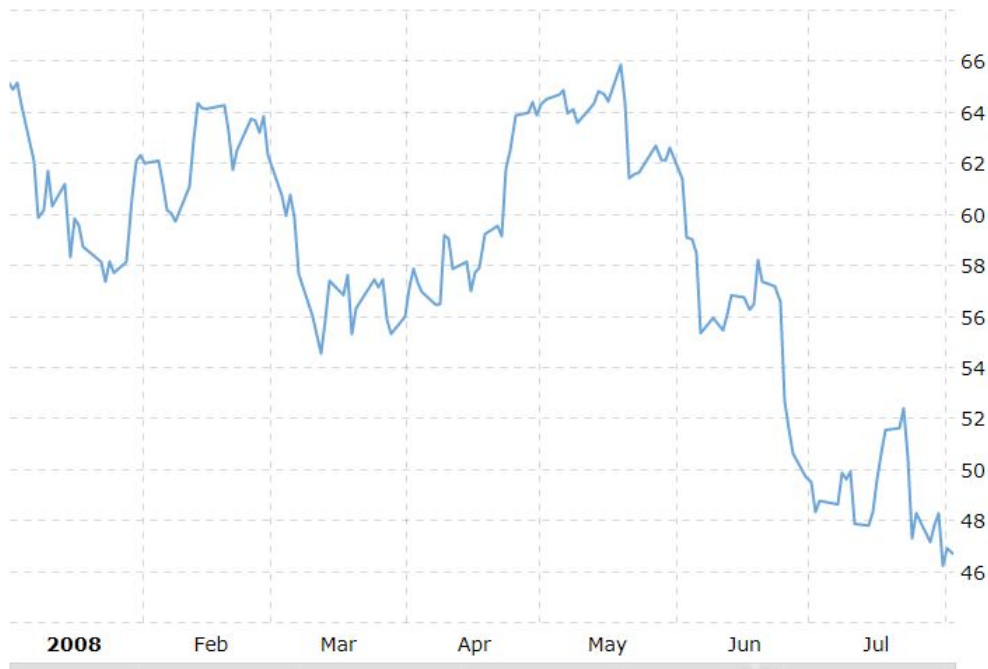
**Figure 9:** The change in stock market value of Boeing during the months January-July 2003 (SARS epidemic) (Taken from macrotrends.net 2020: 1)

Figures 8 and 9 show that both Airbus and Boeing experienced a large decrease in their stock market value during the first three months of 2003. From a stable stock market value in January 2003, Airbus' value decreased to its lowest point at 5.00 by March while Boeing's value decreased from around 24 to a low of around 17 by March, this suggest that the economic impact of the SARS epidemic was the worst during the first three months and as a result both Airbus and Boeing experienced a huge decrease in their values. After this decrease in value, both Airbus and Boeing's values increased thereafter and had a generally positive trend for until July.



**Figure 10:** Change in stock market value of Airbus during the months of January-July during the Great Recession (2008) (Taken from Yahoo Finance 2020: 1)





**Figure 11:** Change in stock market value of Boeing during the months of January-July during Great Recession (2008) (Taken from Macrotrends.net)

Figures 10 and 11 above show that both Boeing and Airbus experienced a general negative trend in their stock market value over the first seven months in 2008. Airbus started 2008 with a stock market value well above 20.00 however this decreased to around 4.00 which is a very drastic change. Boeing also faced a large decrease in their stock market value which fell from the highest value of 66 in May to 47 towards the end of July.

**Table 10:** Overall change in stock market value over the months of January-July during the SARS, the Great Recession and the COVID-19 pandemic.

	<b>SARS (2003)</b>	<b>Great Recession (2008)</b>	<b>COVID-19 (2020)</b>
<b>Airbus</b>	-0.98	-9.46	-145.38
<b>Boeing</b>	-0.3	-16.56	-69.06

The table above shows that global events like epidemics, pandemics and economic downturns bring huge problems to the economy of companies like Airbus and Boeing. However, between the months of January and July, COVID-19 pandemic seems to have brought the worst

decrease in stock market value of both Airbus and Boeing. Airbus' decrease of 0.98 and 9.46 during the SARS and Great Recession seem insignificant when compared to a decrease of 145.38 in 2020. This is also the case for Boeing as their decrease of 0.3 and 16.56 seem insignificant compared to a decrease of 69.06 in 2020. The table also suggests that Airbus also had a bigger decrease in stock market value than Boeing.

**Research questions (2a): What are the types of responses from Airbus and Boeing to the COVID-19 pandemic?**

In the relevant literature analysed the following data were found and statistically analysed. Some of the types of responses made by Airbus and Boeing have been listed below.

**Response Type 1: Job cuts**

**Table 11:** Comparison of the approximate number of job cuts made by Airbus and Boeing as a response to the COVID-19 pandemic

	Approximate number of jobs cut
Airbus	15,000
Boeing	16,000

Both Airbus and Boeing have made drastic changes to their workforce and reduced the number of employees in an effort to downsize the company, this has resulted in a total of almost 31,000 employees losing their jobs. It has been reported by Boeing that 5,500 employees voluntarily resigned from the company while a further 6,800 employees were laid off, this still leaves about 3,700 jobs which will be cut from around the world in order to meet the company's target of a decrease of 16,000 employees. Airbus' cut of 15,000 jobs is the biggest ever downsizing the company has experienced and this highlights the difficulty of the challenges that COVID-19 poses.

**Response Type 2: Airbus' crisis management teams**

In order to manage the recovery process and to put necessary measures into place, Airbus has put together a team of specialists to make crisis management teams at all their sites around the world. The objective of these teams is to make sure that the company is able to deal with any new challenge that comes up through adapting to the situation quickly and efficiently. Ultimately these teams will ensure that the company recovers from this unprecedented situation with the least number of consequences possible. No evidence has been found in the media or on Boeing's websites suggesting that Boeing has got specialist teams like Airbus does.

### **Response Type 3: Production cuts**

Both Airbus and Boeing made the decision to curtail production at their sites in order to save money and resources. They both reduced the number of planes built as a response to the pandemic. Airbus' production cuts resulted in a 46.51% decrease in the total deliveries made between the months of January and July compared to 2019 while Boeing's production cuts also decreased the total number of deliveries made in the same time period by 71.32%. The production cuts made by Airbus include the A320 single aisle aircraft and the A350 long-range jets, Airbus has cut down production of these planes by a third. At Boeing, production of larger planes like the 787 and 777 have been slowed down significantly and the production of the B737 Max planes which were already grounded are also being produced at a much slower rate.

### **Research question (2b): What are the types of responses from Airbus and Boeing to the Great Recession and the SARS epidemic compared with the COVID-19 pandemic?**

As the SARS epidemic happened almost 17 years ago and the Great Recession took place twelve years ago, most of the qualitative data like newspaper articles and journals have been buried by all the new content on the internet, this meant that it was difficult to find information about exact responses that Airbus and Boeing made to these events. Only a few articles detailing some of the most vital decisions of Airbus and Boeing could be found. During the SARS epidemic, Airbus made significantly smaller job cuts compared to the 10,000 jobs that Boeing cut in 2003. During the Great Recession, Boeing removed 350 employees from their workforce in 2008. Information about job cuts made by Airbus was unfortunately not found as all the search results were about the COVID-19 pandemic and job cuts Airbus made in 2020 as this was the most relevant information that was commonly being searched for at the time.

Similar to the information about job cuts, it was also difficult to attain information about the cuts in production made by Airbus and Boeing. Nevertheless, from the data gathered about deliveries made by these companies in 2003 and 2008, it is clear that they did make significant changes to their production in order to save on money and resources. Although Boeing's deliveries decreased during both these events, Airbus' number of deliveries grew surprisingly in 2003 during the SARS and this suggests that their cut on productions were not as extensive as the production cuts they made later in 2008 during the Great Recession.

The responses made by Airbus and Boeing during the SARS epidemic, the Great Recession and the COVID-19 pandemic all seem to be similar, with job cuts and production cuts being the most common ones. As the companies grow and learn through their experience during past global events, they also start to make different responses in order to help the company overcome the challenges it faces, an example of this is the group of crisis management teams that Airbus has set up.

### Research question 3: What are the human factors issues faced by engineers working for Airbus and Boeing?

It could be ascertained from the relevant literature that at Boeing, engineers are closely monitored and supported by a specialist human factors team whose sole responsibility is to study the stress experienced by engineers at the company and to make sure that their employees are fit to work in such a safety critical environment as aircraft manufacturing.

Airbus has also conducted a considerable amount of research into human factors management and this is evident in the documents that have been published by the company detailing their findings and the importance of managing engineers at the company well enough in order to ensure a safe working environment and better productivity.

From the research conducted for the literature review, it has been found that a certain amount of work has been done on understanding human factors issues that affect engineers. These papers highlight the importance of the well-being of engineers and the possible consequences that could be caused by having an overworked or overstressed employee. Some of the side-effects of stress caused by work for engineers include; lack of sleep, fatigue, decrease in blood pressure, varying levels of attention, and so on. There are many other things that also put employees and possibly clients at risk, these include lack of knowledge, lack of resources, pressure, distraction and lack of communication/teamwork. It has been understood that there are a lot of factors that impact the well being of an employee at a company and that these could have dire consequences if not managed properly.

To further understand the human factors issues that an employee at Airbus or Boeing faces, an engineer from Airbus was given a set of questions pertaining to human factors. A summary of the questions the engineer was asked and their respective answers are provided below in Table 12.

**Table 12: Summary of the questions about human factors issues that were asked to an engineer at Airbus.<sup>5</sup>**

Questions	Answers
What is your exact job title?	Licensed Aircraft Engineer at Airbus
What are your main duties at work?	Certification of maintenance carried out by myself and others, team leader running a team of up to 8 mechanics, mentoring and signing experience logbooks.
What are the nature of some of the changes that have occurred at your workplace as a result of the pandemic?	Our shift has been split into 3 groups to reduce the chances of COVID infection. Early, late and night shifts no longer have an overlap of hours, from this shift times

<sup>5</sup> The full list of questions asked to the engineer is presented in the Appendix.

	<p>have also been changed. Staff restaurant is now takeaway only with card payments only. Office staff upstairs are split into 2 shifts to reduce numbers in the office at any time. Our office layout has had to change to allow social distancing.</p>
<p>How has the changes affected you?</p>	<p>I have worked more night shift hours since March than in my entire career so far. I haven't seen some of my colleagues in months. The amount of time my [REDACTED] and I get at home together has changed due to our shift times changing.</p>
<p>Did you worry about job security?</p>	<p>Initially yes, however we are apparently safe due to our contract with the [REDACTED], so my level of concern for myself has reduced massively.</p>
<p>Have you been furloughed?</p>	<p>No</p>
<p>Have any of your colleagues been furloughed and have you seen how this has affected them?</p>	<p>None at Airbus but at British Airways, some have had periods of furlough. Their worry has affected their mental health and it is hard to get a new job amidst the pandemic. I have some very good friends in the industry, it could easily be me in their situation, it worries me that they could lose their job that they love and have worked so hard to attain. I have been regularly checking in with them to make sure they are coping. Having lost a colleague from BA to COVID it has made me realise how important it is to keep in touch with everyone.</p>
<p>Have you experienced any sleeping problems or health issues as a result of this pandemic?</p>	<p>Yes, the unusual working hours due to the changed shift times have messed with my normal sleeping habits.</p>
<p>Have you experienced any concentration issues at the workplace?</p>	<p>Yes, the volume of work has increased massively to ensure maximum availability of aircraft to support the [REDACTED] fight against COVID-19. This means ever changing plans of work to be done and short notice requests for medevac flights to be dispatched. I am not used to having to do such work in the early hours of the morning, so it has been a steep learning curve to adapt to the changing environment at work.</p>
<p>Has Airbus been supporting you through this time of uncertainty?</p>	<p>There are mental health first aiders and phone numbers to call for support - however the awareness of such facilities depends on whether managers have shared them with their teams or not. We are given regular updates on the situation at the company from Airbus and Airbus Defence and Space via email. Things like furlough at different sites, process of voluntary redundancy across Airbus, trade union discussion, financial effects of COVID and the usage of Airbus aircraft to support the fight against COVID-19.</p>
<p>Has Airbus been communicating to you any timeline for recovery?</p>	<p>Yes, this depends on the sector of Airbus in question as it varies. No specific timeline has been communicated but it is expected to be years not months.</p>

<sup>6</sup> Deleted for reasons of privacy.

From the answers that were provided to the questions asked about human factors, it is clear that engineers are affected significantly by changing working environments at their company. The unprecedented nature of COVID-19 has resulted in engineers being overworked in order to allow the company to have as many working hours as possible. Changing work schedules have also disrupted the rhythm of the employees and this could affect their concentration and attention to tasks.

The information provided in this section will be further analysed and compared in the discussion section. This comparative analysis will help to understand whether Airbus or Boeing has been more successful in this period of crisis since a comparison with past events can help to understand the effectiveness of the different types of responses used and an analysis of the answers provided by the engineer can help to see exactly what human factors issues employees experience during a time of crisis like this pandemic.

## 5. Discussion of the Results

The objective of this research project is to understand the impact COVID-19 has had on aircraft manufacturers Airbus and Boeing and also to compare the differences between how it has affected the two companies. Furthermore, in order to put the magnitude of COVID-19 into perspective, the effects of this event were compared to the SARS epidemic and the Great Recession, both events that have had major implications on Airbus and Boeing in the past. Additionally, as there are not many research papers on human factors issues faced by engineers compared to the amount of literature that exists on pilots, it seemed fit to analyse how engineers have been affected during this pandemic as well.

### **Research question (1a): What is the difference in the effects of the COVID-19 pandemic on Airbus and Boeing?**

Comparing the trend in the change in revenue before and after the start of COVID-19 has revealed a lot of information about the experience Airbus and Boeing have had during this time of crisis. As shown in Figure 1 in the Results Section, it can be seen that Boeing's revenue was already on a decline between the years 2018 and 2019 while Airbus' revenue was on an incline. However, after the outbreak of COVID-19 at the end of 2019 both companies' revenue saw a fall in their respective revenues. From Table 1, it can be seen that Airbus' first quarter revenue decreased by 15% compared to 2019 and Boeing's decrease in revenue was almost twice as bad (26%). In 2019 Airbus was able to improve its first quarter revenue by 24% but their growth was halted by the outbreak of COVID-19. Boeing's decreasing trend in their revenue even before COVID-19 could be attributed to the grounding of their best selling aircraft, the B737 Max. Boeing's B737 Max aircraft were grounded after two fatal crashes in 2018 and this could have meant that they were not able to make as much money as they previously did. In terms of revenue, Boeing is doing better than Airbus as they still have a higher revenue however Airbus

seems to have been able to deal with the pandemic better as they saw a smaller decrease in revenue compared to 2019 than Boeing. This could mean that Airbus was able to make the necessary changes at an early stage and so they were able to avoid a further decrease in their revenue.

The deliveries of both Airbus and Boeing's planes were also impacted by the COVID-19 pandemic. This change could be the result of the curtailing in production by Airbus and Boeing or also the result of some of their clients not being able to accept deliveries from the companies. As can be seen in Figure 2, Airbus had made many more deliveries than Boeing in 2019 and also in 2020, and Boeing's decision to make less deliveries or their inability to make more deliveries could have been what caused their revenue to decrease so drastically in the first quarter of 2020 while Airbus experienced a lower decrease in revenue. The change in the number of deliveries made can be seen clearly in Tables 2 and 3. Between January and July in 2020 Airbus made 215 fewer deliveries compared to 2019 while Boeing made 151 fewer deliveries, which highlights the depth of the impact of COVID-19 on both companies as their performance has been hindered by the challenges they are facing in these times.

The economic crisis brought along with the COVID-19 pandemic meant that both Airbus and Boeing experienced a decrease in their stock market value in early 2020. Both companies had a relatively stable stock market value, however as the condition of the pandemic worsened and more measures had to be put in place around the world to stop the situation from worsening even further, both companies saw a decrease in revenue between January and March. In Figure 3 and 4, we can see that Airbus' stock market value decreased by 62% from 138 to 52 while Boeing experienced a decrease of 72% from 348 to 98. COVID-19 affected both Airbus and Boeing's economy in a similar way and both companies' economies have also recovered in a similar fashion. This emphasises how potent a pandemic can be for aerospace manufacturing companies like Airbus and Boeing.

**Research question 2b: What are the differences between how Airbus and Boeing have been affected by COVID-19 compared to the SARS epidemic and the Great Recession.**

The figures discussed in this section are all listed in the results section.

For Airbus, their loss in revenue during the first few months of 2020 is similar to the loss in revenue that the company experienced during the SARS epidemic. During the SARS epidemic (2003) Airbus' first quarter revenue decreased by 14% from the previous year, this is pretty close to a 15% decrease that Airbus experienced in 2020 during the COVID-19 pandemic. Although the SARS epidemic seems to have had almost the same impact, a decrease of 1% is very significant when talking about revenues that are in the billions, this means that COVID-19 still had a worse impact on Airbus than SARS. In the first quarter of 2008, Airbus was able to make a 9.7% increase in revenue from 2007 and this suggests that they were able to adapt to the economic downturn better than the COVID-19 pandemic. Boeing on the other hand seems to have had the worst decrease in revenue during COVID-19 compared to the SARS epidemic

and the Great Recession which again could be attributed to the troubles the company is having with getting the B737 Max aircraft back into service again. Not being able to operate and deliver more “B737 Max” planes which was their best selling aircraft has meant that they have lost a lot of revenue.

In the whole year of 2003 (SARS epidemic) Boeing was only able to deliver 281 planes which was 100 fewer than the number of planes they managed to sell in 2002, in the first seven months of 2020 Boeing has delivered 151 fewer planes than 2019 which is already worse than the figures during the SARS epidemic. This may suggest that Boeing has been forced to make larger production cuts and/or their clients have been able to accept fewer deliveries as a result of COVID-19. After the outbreak of the SARS epidemic, Airbus managed to deliver two more planes than they did in 2002 and comparing this to the COVID-19 pandemic shows that the pandemic has been far worse for Airbus as they have not been able to produce as many planes as they did in 2019 in the first seven months. The likelihood of surpassing the previous years total number of deliveries like they did in 2002 seems very unlikely. The duration of the Great Recession had a significant impact on the deliveries made by Airbus and Boeing between the years of 2007 and 2009. The main impacts of the SARS epidemic only lasted for around a year and thus Airbus and Boeing did not have to resort to making fewer deliveries in order to save money. However during the Great Recession they had to curtail production and deliveries for a longer period of time. By the end of 2009, Airbus made 1148 fewer deliveries than in 2007 while Boeing made 1160 less deliveries than in 2007.

**Research questions (2a): What are the types of responses from Airbus and Boeing to the COVID-19 pandemic and what are the types of responses from Airbus and Boeing to the Great Recession and the SARS epidemic compared with the COVID-19 pandemic?**

As can be seen in Table 11, Airbus and Boeing have made huge job cuts in 2020 as a result of the effects of COVID-19 on the companies. While Airbus made 15,000 jobs cuts, Boeing made 16,000 both of which are the largest downsizing these companies have had to make to date. The decision of both companies to cut jobs appears justified as downsizing the company means that resources can be saved and the extent of the impact of COVID-19 on both companies can be reduced. Both Airbus and Boeing were quick to announce that there were going to be job cuts and this shows that they have learned from previous events that this is a response that has been successful in the past. In both the SARS and the Great Recession, Airbus and Boeing also made job cuts, however these job cuts were made over a longer period of time in small numbers whereas in 2020 during the COVID-19 pandemic, a total of 31,000 jobs at both Airbus and Boeing were cut which is clearly more drastic.

As a result of the job cuts and the downsizing, both companies are also forced to make production cuts due to the reduced workforce. Production cuts can also help companies to save resources in the long run. During the COVID-19 pandemic Airbus and Boeing have curtailed production at their sites and the effects of this can clearly be seen in Figure 2 and Table 2. Between the first seven months in 2020, Airbus and Boeing’s deliveries decreased drastically



compared to the number of deliveries made during this time period in the previous year. Other than production cuts made by the companies themselves, another reason for this change could be the inability of Airbus and Boeing's clients to accept deliveries in this time of crisis due to their own struggles. During the SARS epidemic and the Great Recession, Boeing experienced a fall in the number of deliveries, which is shown in Figure 7 and Table 7. During the SARS epidemic, Airbus managed to actually increase their deliveries from the previous year, this could suggest that they did not make serious cuts on production compared to Boeing. This decision to not make serious production cuts could have been the result for Airbus' higher decrease in revenue as seen in Table 4. During the Great Recession which lasted for almost three years, the decrease in deliveries amounted to around 1500. At this stage of the current pandemic, it does not feel appropriate to compare the production cuts that have been made half way through 2020 with the production cuts that have been made throughout the length of three years during the Great Recession and so it is difficult to compare the effectiveness of this type of response.

Other than the two commonly used responses which are mentioned in a majority of the articles and new reports found online, there are other company specific responses that have been made. An example of this are the groups of crisis management teams set up around the world at Airbus sites, which appears to be a new response because as far as it could be ascertained it was not reported during the SARS epidemic or the Great Recession that a similar response was made. This is a good example of the fact that other than the major changes that have been made at the companies, there are also smaller changes that are not commonly known to the public.

Overall, it appears that Airbus and Boeing have used their past experiences from the global SARS outbreak and the global economic downturn called the Great Recession to improve their already existing responses and recovery methods while also administering new methods where necessary.

### **Research question 3: What are the human factors issues faced by engineers working for Airbus and Boeing?**

The relevant literature about human factors and the questions that were sent to an engineer at Airbus have allowed the impact of an event like COVID-19 on engineers to be explored in detail. From the documents published about human factors, it has been understood that stress in engineers is the most consequential factor. During periods of uncertainty like in the COVID-19 pandemic, employees/engineers are likely to be worried about their job security and this causes them all sorts of psychological stress. The questions directed at the engineer at Airbus were able to provide more information as she also experienced a lot of stress at her workplace due to changing schedules and workload. One of the main problems caused by stress in engineers is the lack of sleep, which means that they are more likely to be tired during their workshifts, and they will also not be able to concentrate on the tasks at hand. The engineer also mentioned that sleep was a problem because of the increased amount of night shifts that she was required to do and this clearly shows that sleeplessness is a common issue that overworked engineers

face. Boeing seems to have a good system to manage their engineers as they have specialist human factors teams with experts who help the company maintain a safe working environment for their employees. Airbus also seems to have adequate systems in place in order to ensure the well-being of their engineers since the engineer at Airbus mentioned that there are mental health helpline numbers that are available and also that the company keeps them updated about the situation at hand.

Overall, it can be concluded that an unprecedented event like the COVID-19 pandemic can have damaging effects on engineers which could be consequential for the companies they work for as they will be much less productive and attentive at work. They could also experience psychological breakdowns due to the increased amount of stress experienced.

## **6. Conclusion**

This research project was conducted in order to understand the impact that COVID-19 has had on aircraft manufacturers Airbus and Boeing. Furthermore the responses made by these companies to COVID-19 were gathered and compared to responses made to previous similarly global events (SARS epidemic and the Great Recession). This research project was carried out in an attempt to understand the effectiveness of the methods through which Airbus and Boeing tried to reduce the extent of the damage caused by events like COVID-19, this information can then hopefully be used in the future to make better responses to similar events.

This research was conducted using a limited amount of data and therefore if it was to be repeated again in the future, a bigger pool of information will be available. In addition to this, a better survey of the human factors issues faced by engineers at Airbus and Boeing could be carried out by having a bigger group of engineers who are willing to participate. Due to the fact that only one engineer was willing to answer the questions, there wasn't a huge range of information available to analyse and study.

The outbreak of COVID-19 has caused a lot of difficulties for Airbus and Boeing, mainly due to the economic implications of the pandemic on the company. As the situation of the pandemic worsened and the population of the virus peaked around the month of April, both Airbus and Boeing saw huge decreases in their revenue and stock market values. From the results that have been gathered it seems that Boeing has been affected more severely than Airbus however although Boeing still has a higher revenue than Airbus even after the outbreak of COVID-19. The differences in the impact of COVID-19 on Airbus and Boeing can only really be understood when this event is considered to be over in a few months or years when a larger amount of data which will be available as this would certainly allow a better picture of the damage caused to be constructed. Due to this current economic downturn Airbus and Boeing were forced to make drastic changes including job cuts from their sites, production cuts and scheduling changes. The results of this research paper indicate that the responses made to the global events in the past, like the SARS epidemic and the Great Recession are similar to the responses made during the

COVID-19 pandemic. Although similar changes were made at the companies during these three events, the severity of the changes varied with the seriousness of the event that the companies were facing. The effectiveness of the responses made by Airbus and Boeing also varied between all these events as a result of extraneous factors that were affecting the companies. For example the grounding of Boeing's B737 Max aircraft in 2018 had huge implications on their revenue over the next two years, and the impact of COVID-19 only made the situation worse for the company. During an event as unpredictable and intense as the COVID-19 pandemic, it is important that the engineers at Airbus and Boeing are looked after very well, the results gathered from having read relevant literature and having received first-hand responses from an engineer at Airbus suggest that both companies have taken necessary measures to ensure that their employees are not overstressed, although factors like changing schedules and increased workloads still affect engineers and this produces a lot of side effects including sleeplessness, lack of attention and tiredness.

# References

- Airbus. 2004. 2003: *A Landmark Year For Airbus*. [online] Available at: <<https://www.airbus.com/newsroom/press-releases/en/2004/01/2003-a-landmark-year-for-airbus.html>> [Accessed 19 August 2020].
- Airbus. 2008. *Financial Results & Annual Reports*. [online] Available at: <<https://www.airbus.com/investors/financial-results-and-annual-reports.html>> [Accessed 19 August 2020].
- Airbus. 2020. *Airbus Plans To Further Adapt To COVID-19 Environment*. [online] Available at: <<https://www.airbus.com/newsroom/press-releases/en/2020/06/airbus-plans-to-further-adapt-to-covid19-environment.html>> [Accessed 16 July 2020].
- Airbus. 2020. *Airbus Reports First Quarter (Q1) 2020 Results*. [online] Available at: <<https://www.airbus.com/newsroom/press-releases/en/2020/04/airbus-reports-first-quarter-q1-2020-results.html>> [Accessed 18 August 2020].
- Airbus. 2020. *Airbus Reports Full-Year (FY) 2019 Results, Delivers On Guidance*. [online] Available at: <<https://www.airbus.com/newsroom/press-releases/en/2020/02/airbus-reports-full-year-2019-results.html>> [Accessed 29 July 2020].
- Airbus. 2020. *An Unprecedented Airbus Mobilisation For The COVID-19 Pandemic*. [online] Available at: <<https://www.airbus.com/newsroom/stories/airbus-mobilisation-covid-19.html>> [Accessed 23 July 2020].
- Annualreports.com. 2003. *The Boeing Company 2003 Annual Report*. [online] Available at: <[https://www.annualreports.com/HostedData/AnnualReportArchive/b/NYSE\\_BA\\_2003.pdf](https://www.annualreports.com/HostedData/AnnualReportArchive/b/NYSE_BA_2003.pdf)> [Accessed 14 August 2020].
- Arpansa. 2017. *Human Factors*. [online] Available at: <<https://www.arpansa.gov.au/regulation-and-licensing/safety-security-transport/holistic-safety/human-factors>> [Accessed 10 August 2020].
- BBC News. 2020. *Boeing To Cut 15,000 Jobs In Covid-19 'Body Blow'*. [online] Available at: <<https://www.bbc.co.uk/news/business-52468882>> [Accessed 16 July 2020].
- Buyck, C., 2020. *Airbus Taking 'Schizophrenic' Approach To Coronavirus Crisis, CEO Says*. [online] Forbes. Available at: <<https://www.forbes.com/sites/cathybuyck/2020/04/29/airbus-has-schizophrenic-approach-to-covid-19-crisis-european-planemaker-ceo-says/#1952f62e2e6c>> [Accessed 23 July 2020].
- Chhinzer, N., 2020. *How And Why Companies Lay Off Employees Affects Future Success*. [online] The Conversation. Available at: <<https://theconversation.com/how-and-why-companies-lay-off-employees-affects-future-success-136356>> [Accessed 20 August 2020].
- CAA - Civil Aviation Authority SAFETY NOTICE, 2020. *The Effect On Aviation Mental Health From the Covid-19 Pandemic and Return to Re-defined 'Normal' Flight Operations*.



Forbes.com. 2008. *November 2008 Layoffs* [online] Available at: <[https://www.forbes.com/2008/11/18/november-layoffs-fires-lead-cx\\_kk\\_1118november08layoffs.html](https://www.forbes.com/2008/11/18/november-layoffs-fires-lead-cx_kk_1118november08layoffs.html)> [Accessed 28 July 2020].

Guessos, H., 2020. *Airbus To Cut 15,000 Jobs To Cope With COVID-19 Crisis Repercussions*. [online] Morocco World News. Available at: <<https://www.moroccoworldnews.com/2020/07/307441/airbus-to-cut-15000-jobs-to-cope-with-covid-19-crisis-repercussions/>> [Accessed 28 August 2020].

Harris, R., 2008. *Financial crisis means rougher flying for Boeing*. [online]. Available at: <<https://www.cfo.com/strategy/2008/09/financial-crisis-means-rougher-flying-for-boeing/>> [Accessed 23 July 2020]

Investigate.co.uk. 2008. *Investigate | Boeing Co Announcements | Boeing Co: 1St Quarter Results*. [online] Available at: <<https://www.investigate.co.uk/boeing-co/prn/1st-quarter-results/20080423123803PD883/>> [Accessed 19 August 2020].

Investors.boeing.com. 2020. *Boeing Reports First-Quarter Results*. [online] Available at: <<https://investors.boeing.com/investors/investor-news/press-release-details/2020/Boeing-Reports-First-Quarter-Results/default.aspx>> [Accessed 18 August 2020].

Kasper, J., 2020. *Airbus And Boeing Report July 2020 Commercial Aircraft Orders And Deliveries*. [online] Defense Security Monitor. Available at: <<https://dsm.forecastinternational.com/wordpress/2020/08/17/airbus-and-boeing-report-july-2020-commercial-aircraft-orders-and-deliveries/>> [Accessed 18 August 2020].

Kelly, H., 2011. *WHO | The Classical Definition Of A Pandemic Is Not Elusive*. [online] Who.int. Available at: <<https://www.who.int/bulletin/volumes/89/7/11-088815/en/>> [Accessed 9 August 2020].

Koenig, D., 2020. *Boeing Announces Job, Production Cuts*. [online] Manufacturing.net. Available at: <<https://www.manufacturing.net/aerospace/news/21130847/boeing-announces-job-production-cuts>> [Accessed 20 August 2020].

Los Angeles Times. 2003. *Boeing Gives Layoff Notices To 845 Workers*. [online] Available at: <<https://www.latimes.com/archives/la-xpm-2003-jun-21-fi-rup21.10-story.html>> [Accessed 14 August 2020].

Macrotrends.net. 2020. *Boeing - 58 Year Stock Price History | BA*. [online] Available at: <<https://www.macrotrends.net/stocks/charts/BA/boeing/stock-price-history>> [Accessed 19 August 2020].

Macrotrends.net. 2020. *Boeing Revenue 2006-2020 | BA*. [online] Available at: <<https://www.macrotrends.net/stocks/charts/BA/boeing/revenue>> [Accessed 31 July 2020].

Mazareanu (a), E., 2020. *Topic: Airbus And Boeing*. [online] Statista. Available at: <<https://www.statista.com/topics/3697/airbus-and-boeing/>> [Accessed 29 August 2020].

Mazareanu (b), E., 2020. *Topic: Boeing's worldwide revenue 2019*. [online] Statista. Available at: <<https://www.statista.com/statistics/264374/boeings-worldwide-revenue/>> [Accessed 29 July 2020]

MediaRoom. 2009. *Boeing Reports First-Quarter Earnings*. [online] Available at: <<https://boeing.mediaroom.com/2009-04-22-Boeing-Reports-First-Quarter-Earnings>> [Accessed 19 August 2020].

Nytimes.com. 2008. *Airbus Ready To Shrink Output If Global Crisis Deepens*. [online] Available at: <<https://www.nytimes.com/2008/11/25/business/worldbusiness/25iht-airbus.4.18151654.html>> [Accessed 23 July 2020].

Rutherford, S., 2017. (PDF) *The Pandemic And Its Impacts*. [online] ResearchGate. Available at: <[https://www.researchgate.net/publication/321689453\\_The\\_Pandemic\\_and\\_its\\_Impacts](https://www.researchgate.net/publication/321689453_The_Pandemic_and_its_Impacts)> [Accessed 12 August 2020].

Satow, R., 1999. *The Role Of Human Factors In Improving Aviation Safety - Text Only*. [online] Boeing.com. Available at: <[http://www.boeing.com/commercial/aeromagazine/aero\\_08/human\\_textonly.html](http://www.boeing.com/commercial/aeromagazine/aero_08/human_textonly.html)> [Accessed 31 July 2020].

Skates, K., 2020. *Written Statement: Impact Of Coronavirus On The Aerospace Industry | GOV.WALES*. [online] GOV.WALES. Available at: <<https://gov.wales/written-statement-impact-coronavirus-aerospace-industry>> [Accessed 25 July 2020].

Statista. 2020. *Aircraft Orders - Airbus And Boeing 2006-2019 | Statista*. [online] Available at: <<https://www.statista.com/statistics/264492/aircraft-orders-from-airbus-and-boeing/>> [Accessed 26 August 2020].

The Financial Express. 2002. *Boeing To Cut Another 5,000 Jobs In 2003*. [online] Available at: <<https://www.financialexpress.com/archive/boeing-to-cut-another-5000-jobs-in-2003/64949/>> [Accessed 28 July 2020].

The Irish Times. 2002. *Boeing To Cut A Further 5,000 Jobs In 2003*. [online] Available at: <<https://www.irishtimes.com/news/boeing-to-cut-a-further-5-000-jobs-in-2003-1.448089>> [Accessed 14 August 2020].

Who.int. 2019. *Severe Acute Respiratory Syndrome (SARS)*. [online] Available at: <<https://www.who.int/health-topics/severe-acute-respiratory-syndrome>> [Accessed 14 August 2020].

WSJ. 2003. *Boeing Delivered 381 Planes in 2002, One Above Forecast*. [online] Available at: <<https://www.wsj.com/articles/SB1041903277565730904>> [Accessed 19 August 2020].

# Bibliography

2020. *Human Factors*. FAA Safety. [Book]

Airbus. 2004. 2003: *A Landmark Year For Airbus*. [online] Available at: <<https://www.airbus.com/newsroom/press-releases/en/2004/01/2003-a-landmark-year-for-airbus.html>> [Accessed 19 August 2020].

Airbus. 2008. *Financial Results & Annual Reports*. [online] Available at: <<https://www.airbus.com/investors/financial-results-and-annual-reports.html>> [Accessed 19 August 2020].

Airbus. 2020. *Airbus Plans To Further Adapt To COVID-19 Environment*. [online] Available at: <<https://www.airbus.com/newsroom/press-releases/en/2020/06/airbus-plans-to-further-adapt-to-covid19-environment.html>> [Accessed 16 July 2020].

Airbus. 2020. *Airbus Reports First Quarter (Q1) 2020 Results*. [online] Available at: <<https://www.airbus.com/newsroom/press-releases/en/2020/04/airbus-reports-first-quarter-q1-2020-results.html>> [Accessed 18 August 2020].

Airbus. 2020. *Airbus Reports Full-Year (FY) 2019 Results, Delivers On Guidance*. [online] Available at: <<https://www.airbus.com/newsroom/press-releases/en/2020/02/airbus-reports-full-year-2019-results.html>> [Accessed 29 July 2020].

Airbus. 2020. *An Unprecedented Airbus Mobilisation For The COVID-19 Pandemic*. [online] Available at: <<https://www.airbus.com/newsroom/stories/airbus-mobilisation-covid-19.html>> [Accessed 23 July 2020].

Airbus. 2019. *Global Market Forecast 2019-2038*. [online] Available at: <<https://www.airbus.com/aircraft/market/global-market-forecast.html>> [Accessed 28 July 2020].

Annualreports.com. 2003. *The Boeing Company 2003 Annual Report*. [online] Available at: <[https://www.annualreports.com/HostedData/AnnualReportArchive/b/NYSE\\_BA\\_2003.pdf](https://www.annualreports.com/HostedData/AnnualReportArchive/b/NYSE_BA_2003.pdf)> [Accessed 14 August 2020].

Arpansa. 2017. *Human Factors*. [online] Available at: <<https://www.arpansa.gov.au/regulation-and-licensing/safety-security-transport/holistic-safety/human-factors>> [Accessed 10 August 2020].

BBC News. 2020. *Boeing To Cut 15,000 Jobs In Covid-19 'Body Blow'*. [online] Available at: <<https://www.bbc.co.uk/news/business-52468882>> [Accessed 16 July 2020].

Bellamy III, W., 2020. *Airbus, Boeing Make Production Decisions Amid COVID-19 Pandemic - Aviation Today*. [online] Aviation Today. Available at: <<https://www.aviationtoday.com/2020/03/24/airbus-boeing-make-production-decisions-amid-covid-19-pandemic/>> [Accessed 28 July 2020].

Boeing.com. 2020. *Boeing: Information For Boeing Employees And Retirees About COVID19*. [online] Available at: <<http://www.boeing.com/covid19/employees.page>> [Accessed 27 July 2020].



Buyck, C., 2020. *Airbus Taking 'Schizophrenic' Approach To Coronavirus Crisis, CEO Says*. [online] Forbes. Available at: <<https://www.forbes.com/sites/cathybuyck/2020/04/29/airbus-has-schizophrenic-approach-to-covid-19-crisis-european-planemaker-ceo-says/#1952f62e2e6c>> [Accessed 23 July 2020].

Chhinzer, N., 2020. *How And Why Companies Lay Off Employees Affects Future Success*. [online] The Conversation. Available at: <<https://theconversation.com/how-and-why-companies-lay-off-employees-affects-future-success-136356>> [Accessed 20 August 2020].

CHIRP (2020), *AIR TRANSPORT FEEDBACK* [online]. [Accessed 27 July 2020]

Cirium - A Smarter Way. 2020. *COVID-19: Navigating The Flight Plan To Recovery - DAILY UPDATE - Cirium - A Smarter Way*. [online] Available at: <<https://www.cirium.com/thoughtcloud/covid-19-navigating-the-flight-plan-to-recovery-daily-update/>> [Accessed 28 July 2020].

*Civil Aviation Authority SAFETY NOTICE*, 2020. The Effect On Aviation Mental Health From the Covid-19 Pandemic and Return to Re-defined 'Normal' Flight Operations.

Cole, A., 2004. *Airbus Deliveries Top Boeing's In 2003*. [online] MarketWatch. Available at: <<https://www.marketwatch.com/story/airbus-deliveries-ahead-of-boeing-for-first-time-in-03>> [Accessed 19 August 2020].

Council on Foreign Relations. 2020. *Major Epidemics Of The Modern Era*. [online] Available at: <<https://www.cfr.org/timeline/major-epidemics-modern-era>> [Accessed 10 August 2020].

Crane, E., 2020. *Boeing CEO Predicts A Major US Airline Will Fold Due To COVID-19*. [online] Mail Online. Available at: <<https://www.dailymail.co.uk/news/article-8311449/Boeing-CEO-predicts-major-airline-fold-COVID-19.htm>> [Accessed 29 July 2020].

Davies, P., 2020. *Which Companies In Europe Are Cutting Jobs Because Of COVID-19?*. [online] euronews. Available at: <<https://www.euronews.com/2020/07/24/coronavirus-job-cuts-which-companies-in-europe-are-slashing-their-workforces-because-of-co>> [Accessed 18 July 2020].

Decorse, J. and Kraemer, C., 2020. *Airbus Hints At Compromise As Governments Fret Over Job Cuts*. [online] U.K. Available at: <<https://uk.reuters.com/article/us-airbus-restructuring-france/airbus-hints-at-compromise-as-governments-fret-over-job-cuts-idUKKBN2424RE>> [Accessed 28 July 2020].

Drury, C., 2020. *Human Factors In Aircraft Maintenance*. New York. [book]

Dutton, G., 2020. *Compare: 2003 SARS Pandemic Versus 2020 COVID-19 Pandemic* | Biospace. [online] BioSpace. Available at:



<<https://www.nytimes.com/2020/03/17/business/economy/boeing-coronavirus-economy.html>> [Accessed 29 July 2020].

Gosling, S., Scott, D. and Hall, M., 2020. *Pandemics, Tourism And Global Change: A Rapid Assessment Of COVID-19*. [online] Taylor & Francis. Available at: <<https://www.tandfonline.com/doi/full/10.1080/09669582.2020.1758708>> [Accessed 21 July 2020].

Guessos, H., 2020. *Airbus To Cut 15,000 Jobs To Cope With COVID-19 Crisis Repercussions*. [online] Morocco World News. Available at: <<https://www.moroccoworldnews.com/2020/07/307441/airbus-to-cut-15000-jobs-to-cope-with-covid-19-crisis-repercussions/>> [Accessed 28 August 2020].

Harris, R., 2008. *Financial crisis means rougher flying for Boeing*. [online]. Available at: <<https://www.cfo.com/strategy/2008/09/financial-crisis-means-rougher-flying-for-boeing/>> [Accessed 23 July 2020]

Investegate.co.uk. 2008. *Investegate | Boeing Co Announcements | Boeing Co: 1St Quarter Results*. [online] Available at: <<https://www.investegate.co.uk/boeing-co/prn/1st-quarter-results/20080423123803PD883/>> [Accessed 19 August 2020].

Investors.boeing.com. 2020. *Boeing Reports First-Quarter Results*. [online] Available at: <<https://investors.boeing.com/investors/investor-news/press-release-details/2020/Boeing-Reports-First-Quarter-Results/default.aspx>> [Accessed 18 August 2020].

Isidore, C., 2008. *Boeing Strike Another Hit To The Economy - Sep. 12, 2008*. [online] Money.cnn.com. Available at: <[https://money.cnn.com/2008/09/12/news/economy/boeing\\_impact/index.htm](https://money.cnn.com/2008/09/12/news/economy/boeing_impact/index.htm)> [Accessed 28 July 2020].

Johnson, E., 2020. *COVID Floors Aero Suppliers After Years Of Planemaker Blows*. [online] U.K. Available at: <<https://uk.reuters.com/article/us-usa-aerospace-boeing-airbus-focus/covid-floors-aero-suppliers-after-years-of-planemaker-blows-idUKKCN24M1VE>> [Accessed 25 July 2020].

Kasper, J., 2020. *Airbus And Boeing Report July 2020 Commercial Aircraft Orders And Deliveries*. [online] Defense Security Monitor. Available at: <<https://dsm.forecastinternational.com/wordpress/2020/08/17/airbus-and-boeing-report-july-2020-commercial-aircraft-orders-and-deliveries/>> [Accessed 18 August 2020].

Kelly, H., 2020. *WHO | The Classical Definition Of A Pandemic Is Not Elusive*. [online] Who.int. Available at: <<https://www.who.int/bulletin/volumes/89/7/11-088815/en/>> [Accessed 9 August 2020].

King, J., 2007. The Airbus 380 and Boeing 787: A role in the recovery of the airline transport market. *Journal of air transport management*, [online] 13(1). Available at: <<https://www.sciencedirect.com/science/article/abs/pii/S0969699706001025>> [Accessed 31 July 2020].

Koenig, D., 2020. *Boeing Announces Job, Production Cuts*. [online] Manufacturing.net. Available at: <<https://www.manufacturing.net/aerospace/news/21130847/boeing-announces-job-production-cuts>> [Accessed 20 August 2020].

Kurt, D., 2020. *The Special Economic Impact Of Pandemics*. [online] Investopedia. Available at: <<https://www.investopedia.com/special-economic-impact-of-pandemics-4800597>> [Accessed 31 July 2020].

Los Angeles Times. 2003. *Boeing Gives Layoff Notices To 845 Workers*. [online] Available at: <<https://www.latimes.com/archives/la-xpm-2003-jun-21-fi-rup21.10-story.html>> [Accessed 14 August 2020]

Macrotrends.net. 2020. *Boeing - 58 Year Stock Price History | BA*. [online] Available at: <<https://www.macrotrends.net/stocks/charts/BA/boeing/stock-price-history>> [Accessed 19 August 2020].

Macrotrends.net. 2020. *Boeing Revenue 2006-2020 | BA*. [online] Available at: <<https://www.macrotrends.net/stocks/charts/BA/boeing/revenue>> [Accessed 31 July 2020].

Manufacturing.net. 2007. *Boeing, Airbus Face Delays*. [online] Available at: <<https://www.manufacturing.net/operations/news/13060765/boeing-airbus-face-delays>> [Accessed 29 July 2020].

Marris, S., 2020. *Coronavirus: Boeing Cuts 12,000 Jobs As COVID-19 Crisis Savages Plane Industry*. [online] Sky News. Available at: <<https://news.sky.com/story/coronavirus-boeing-cuts-12-000-jobs-as-covid-19-crisis-savages-plane-industry-11995713>> [Accessed 27 July 2020].

Mazareanu, E., 2020. *Topic: Airbus And Boeing*. [online] Statista. Available at: <<https://www.statista.com/topics/3697/airbus-and-boeing/>> [Accessed 29 August 2020].

Mazareanu, E., 2020. *Topic: Boeing's worldwide revenue 2019*. [online] Statista. Available at: <<https://www.statista.com/statistics/264374/boeings-worldwide-revenue/>> [Accessed 29 July 2020]

MediaRoom. 2009. *Boeing Reports First-Quarter Earnings*. [online] Available at: <<https://boeing.mediaroom.com/2009-04-22-Boeing-Reports-First-Quarter-Earnings>> [Accessed 19 August 2020].

Nytimes.com. 2008. *Airbus Ready To Shrink Output If Global Crisis Deepens*. [online] Available at: <<https://www.nytimes.com/2008/11/25/business/worldbusiness/25iht-airbus.4.18151654.html>> [Accessed 23 July 2020].

PwC. 2020. *COVID-19: What It Means For The Aerospace And Defense Industry*. [online] Available at: <<https://www.pwc.com/us/en/library/covid-19/coronavirus-impacts-aerospace-and-defense.html>> [Accessed 20 July 2020].

Rutherford, S., 2020. (PDF) *The Pandemic And Its Impacts*. [online] ResearchGate. Available at: <[https://www.researchgate.net/publication/321689453\\_The\\_Pandemic\\_and\\_its\\_Impacts](https://www.researchgate.net/publication/321689453_The_Pandemic_and_its_Impacts)> [Accessed 12 August 2020].

Satow, R., 1999. *The Role Of Human Factors In Improving Aviation Safety - Text Only*. [online] Boeing.com. Available at:

<[http://www.boeing.com/commercial/aeromagazine/aero\\_08/human\\_textonly.html](http://www.boeing.com/commercial/aeromagazine/aero_08/human_textonly.html)> [Accessed 31 July 2020].

Segal, S., 2018. *ANALYSIS: What The Great Recession Meant For Aircraft Funding*. [online] Flight Global. Available at: <<https://www.flightglobal.com/analysis/analysis-what-the-great-recession-meant-for-aircraft-funding/129424.article>> [Accessed 28 July 2020].

Skates, K., 2020. *Written Statement: Impact Of Coronavirus On The Aerospace Industry | GOV.WALES*. [online] GOV.WALES. Available at: <<https://gov.wales/written-statement-impact-coronavirus-aerospace-industry>> [Accessed 25 July 2020].

Statista. 2020. *Aircraft Orders - Airbus And Boeing 2006-2019 | Statista*. [online] Available at: <<https://www.statista.com/statistics/264492/aircraft-orders-from-airbus-and-boeing/>> [Accessed 26 August 2020].

Tangel, D., 2020. *Boeing And Airbus Brace For Prolonged Downturn Triggered By Coronavirus*. [online] WSJ. Available at: <<https://www.wsj.com/articles/boeing-and-airbus-brace-for-prolonged-downturn-triggered-by-coronavirus-11588199021>> [Accessed 28 July 2020].

The Economist. 2008. *Crisis? What Crisis?*. [online] Available at: <<https://www.economist.com/business/2008/07/17/crisis-what-crisis>> [Accessed 31 August 2020].

The Financial Express. 2002. *Boeing To Cut Another 5,000 Jobs In 2003*. [online] Available at: <<https://www.financialexpress.com/archive/boeing-to-cut-another-5000-jobs-in-2003/64949/>> [Accessed 28 July 2020].

The Irish Times. 2002. *Boeing To Cut A Further 5,000 Jobs In 2003*. [online] Available at: <<https://www.irishtimes.com/news/boeing-to-cut-a-further-5-000-jobs-in-2003-1.448089>> [Accessed 14 August 2020].

Who.int. 2019. *Severe Acute Respiratory Syndrome (SARS)*. [online] Available at: <<https://www.who.int/health-topics/severe-acute-respiratory-syndrome>> [Accessed 14 August 2020].

WSJ. 2003. *Boeing Delivered 381 Planes in 2002, One Above Forecast*. [online] Available at: <<https://www.wsj.com/articles/SB1041903277565730904>> [Accessed 19 August 2020].

# Appendix

The questions asked to the engineer at Airbus are listed below:

1. What is your exact job title at Airbus?
2. What are your main job duties?
3. Since the outbreak of the pandemic, has anything changed at the workplace?
4. If yes to (3), what is the nature of these changes?
5. If yes to (3), how have these changes affected you?
6. Do you/Did you worry about your job security at Airbus during this pandemic?
7. If yes to (6), in what way have your worries manifested?
8. Have you been furloughed?
9. If yes to (8), are you concerned that there may not be a job available for you once the scheme is over in October?
10. Have any of your engineer colleagues been furloughed?
11. Do any job worries of your colleagues affect you?
12. If yes to (11), in which way do your colleagues' concerns affect you?
13. Do you/Did you have any sleeping problems or health issues as a result of the changes that this pandemic has caused?
14. If yes to (13) please describe the nature of your issues.
15. Do you/Did you have any concentration issues at the workplace due to the changes that this pandemic has caused?
16. If yes to (15), how do they/did they manifest?
17. Do you know any other engineers at Airbus that have been facing the issues mentioned in questions (13) and (15)?
18. Has Airbus directed their staff to any mental health resources that are available to them?
19. Has Airbus encouraged their managers to check in with their team members regularly?
20. Has Airbus been communicating with you during this pandemic?
21. If yes to (20), in which way has Airbus been communicating with you and your colleagues?
22. Has Airbus made sure that every employee is aware of what is going on at the company?
23. If yes to (22), could you please describe what type of information Airbus has shared with you?
24. Has Airbus been communicating to you any timeline for recovery?
25. If yes to (24), what is/are the predicted timelines?
26. Do you have any other comments that you would like to add?