A Comparative Analysis Between Airbus and the Concorde on their Organizational Structure and Success of Products in the Aerospace Market

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia | Charlottesville, VA

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

By

Nicholas Storey

April 30, 2023

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for the Thesis-Related Assignments

Introduction

The 20th Century was full of innovations, including both during and after the World Wars, with many new technologies emerging in many disciplines. Among those was the Concorde, a collaborative aircraft project that originated in Europe between France and England. This plane was futuristic, with very angular wings and a sharp nose aimed down like a bird, and would fly faster than any commercial plane before its time. Both France and England worked on developing this plane, beginning in the 1950s and the final product was on the market until the start of the 21st century, and the result was this supersonic aircraft designed to bring the best to the air. As Aldridge (2001) describes, "It was a futuristic dream – the world's safest and most stylish plane … Rich blue pinstriped carpets, cashmere blankets and lambswool curtains echo Savile Row tailoring." Accomplishing tasks that companies even nowadays are still working to perfect, the Concorde was truly ahead of its time, "both an engineering marvel and a model of international collaboration." (Latson, 2014)

But all was not perfect with this beautiful piece of engineering; France and England were bogged down with delays and underestimates in time and budgets, and once completed, did not have the exceptional performance that would be expected to accompany its looks. With the prototype's maiden light approaching in the coming months, *Time* magazine revealed that the original estimates were $450 million dollars, and ended up being $1.4 billion between the two countries, over 3 times the expected cost ("Aviation," 1967). In this piece, concerns over the fuel usage are mentioned, as well as it not having been approved by the Federal Aviation Administration which leads to uncertainty over how well this performed in the market. Behind the design of these planes, even before a prototype was created, the two countries created a project structure that was very messy and not conducive to efficient communication and innovation, and generated disagreements between both sides of the project. Among the headaches and disagreements, the British even tried to back out of an agreement made between France and England in 1962, where the Labour Government found out that it was more binding than they thought, and were forced to continue its development (Henderson, 1977). While the final product may have been used in the market, the collaboration during its lengthy development and manufacturing could have been setup more efficiently and led to an overall better project. The continued collaboration in the current aerospace industry suggests it is important to analyze what was done and how it can be improved for more modern applications.

With the development of the Concorde being more strenuous on France and England's resources and time, modern companies like Airbus tend to adopt a more integrated and collaborative-focused approach to large-scale projects, such as aircraft, to produce more successful products. In this paper, a comparison will be made between the Concorde, an Anglo-French project, and Airbus, a multinational European aerospace company, focusing on how their practices used in designing and manufacturing affect their projects. The setup of both will be examined using the Social Construction of Technology (SCOT) developed by Pinch and Bijker (1984) to frame each party involved and their influence, to determine the effect had by each. The result of this paper will be an analysis of different engineering approaches to large projects using SCOT to determine how they impact the final result.

Literature Review

To understand the nuances of the analysis, it is necessary to understand where these both the Concorde and Airbus originate and how they relate to one another. The Concorde and its development date back to the 1950s when the original ideas were created for its estimated range, size, and usage. Eventually, a prototype and final design were made and the Concorde became a reality, flying until the beginning of the 21st century when it was ultimately grounded, with its final voyage bringing it to a museum in Seattle, WA in November 2003 (Farah & Xavier, 2019). Among other things, the poor fuel economy led to the plane becoming unprofitable to operate, and could not always fly at supersonic speeds to due to sonic shock concerns, both of which contributed to its removal from the market. There were no technologies in place to reduce the shock effects, and any would need to not compromise the efficiency as it was already poor; the effects of the shock waves were felt on the ground as they propagated from the plane, and could cause damage, meaning it could not fly at its designed cruising speed (Candel, 2004). However, these issues could have mitigated long before the Concorde was actually flying.

Airbus, a multinational European aerospace company, undertakes similar responsibilities that the Concorde team needed to decades prior, having to distribute efforts between contractors and developing a large-scale product in the smaller market that is initially Europe, before expanding to others. With the British, French, and Germans venturing together with Airbus, collaboration has been a central theme and they have even been described as acting more like a single national firm, rather than a group of nations working together (Hayward, 1975); Hayward continues and contends that this form of collaboration is a natural progression and is becoming more permanent in the industry. Studies performed on Airbus' methods have shown that their design consists of multiple processes happening concurrently across many teams and continue throughout a product's lifespan. Their aim is to integrate these all into one platform, encouraging teams to work at the same time and engage with the work of others, the most efficient form of collaboration (Mas et al., 2014). Work has also been done by Koenig and Thietart (1988) to find why European efforts were more collaborative than others What they found is in order to compete in the world market, European companies have needed to collaborate and share resources to be able to match the sheer size and resources of the US and other companies/markets, and with these large projects many contractors and capital are needed to bring together all the necessary aspects. Thus, the European markets act more as one and the countries within have undergone ventures together in hopes of being able to bring to a more successful product to market.

The framework that I use to analyze these two situations is the Social Construction of Technology, developed by Pinch and Bijker (1984), with its main focus being how society helps shape and develop products and technologies. Relevant social groups are the main way to identify the influences between society and a technology, with them being defined as groups of individuals that have a shared view or effect from a technology. These do not need to be pre-defined groups, but are separated by their attached meanings to certain artifacts, in this case the engineering projects. The commonality within these groups is their meanings but they are not shared across social groups. Another main part of the framework is interpretative flexibility, which says there are multiple ways for people to think about a technology, but also includes how the technology is designed meaning the influences of the designer are put into the technology. This leads into the former in the way that it is a reciprocal relationship, the influence goes to the technology and comes from it, creating a dynamic relationship between the relevant social group and the technology. In this application, the framework will examine how those involved in the design and manufacturing influenced the technology, whether it's the Concorde or Airbus' products. The relevant social groups are more well defined than in other situations, but each still have their own unique impacts and influences to each project.

Methods

This analysis consists of two distinct entities that are working on similar projects: the Concorde project and Airbus. Due to the nature of the projects and teams examined in this paper, the majority of the sources used for evidence come from academic research into practices, as well as conference papers dating back to the period when the Concorde was being developed in the mid-to-late 20th century. This ensures that the information obtained is mostly secondhand, but accurate as it comes from those who analyzed the teams directly, and made conclusions or stated their findings. The discussions I hoped to find on the Concorde were about the decision making and structure for its development and design, whereas with Airbus it's more about their current practices and efforts to ensure collaboration, as that is the contrast between the two. Supplemental sources were obtained to help with connecting pieces of information together; for example, sources include headlines about the Concorde as it was being put on the market and its descriptions of the interior or the public view of it. As for Airbus, these supplemental sources, besides academic journals looking at their company, include company releases about their executive structure and how their divisions are separated, including how they also work together. Beyond the two teams, research was done to find an explanation on why the European aerospace industry collaborate more than other parts of the world, with results coming back with market and resource analysis that explain this trend in their larger projects.

Reviewing all of these types of sources listed above, I will identify the different groups affiliated with the respective projects using the SCOT framework to break apart and form each group based on their influence and effect on and from the technology of their respective project. The main focus of these groups will be in their engineering teams and committees, with the public/market being a smaller portion of the groups, since their real influence only came once the product was on the market; however, they will be included since it is their influence and effect that determines the success of the product as it's in use. Looking at these two examples using this framework can help distinguish what each project group has as responsibilities and how they viewed the technology to affect the decisions made. Since one of the examples has already concluded, the entirety of the project can be analyzed and lead to some extrapolation to the more modern example. SCOT allows the flexibility to assign, in this scenario, a more realistic influence to teams of people rather than what they are officially listed as, considering motives politically and technically. Analyzing the SCOT influences and relevant social groups with the relative success of each project will lead to a comparative analysis between Airbus and the Concorde, both of which are European, multinational, collaborative efforts to produce aerospace products in both a historical and more modern context.

Analysis

The idea for the Concorde was novel for its time, stemming from interest from the French and English in supersonic transport in the late 1950s and early 1960s when they were looking for a medium or long-range design. The British government was looking for a collaboration partner and landed on the French after looking abroad, which would then give both governments monetary incentive to complete this project together, with a secondary goal of the Concorde being the engineering accomplishments. This partnership was formalized in 1962, which previously mentioned was the one that the British tried to back out of after realizing estimates were incorrect, where two versions were envisioned: a medium range and a long range with a higher take-off weight (Hamilton, 1968). Beyond technical goals, as Nelson (1969) details, France and England hoped to make economic gains, with England expecting to join a common market within Europe, and working cooperatively with France would facilitate this. Since the project stretched across borders, more oversight was needed to ensure every team met their expectations and contributed to the whole project. This led to a large number of committees and structures put in place for both England and France; Nelson (1969) once again points out that each country did not want their contractors to merge with another nation's, so each contractor would stay separate and work under their respective governments, and need to convene with their counterpart on the design. And with this setup, both the airframe and engine work was delegated to a contractor from each country: BAC for the airframe and Bristol Siddeley for the engine (British), with Sud for the airframe and SNECMA for the engine (French).

The makeup of the Concorde project itself was very muddied with committees, even considering that two nations were working together on the development. As Hamilton (1968) described, there were numerous committees and subcommittees assigned to aspects of the project. Among the original members, there were the two governments, as well as two contractors a piece for both the airframe and engine, and once agreements were in place, they could not be altered easily. Then, an equivalent to a Board of Directors was established, followed by a subcommittee more devoted to the Concorde as they could not dedicate the appropriate amount of time to the project, and furthermore, Committees of Directors were made for the engine and airframe firms, nevertheless leading to a very involved and complicated organization structure for a very complex technical project. Notably, there was a time when the British tried to back out of the project, and because these agreements were so binding with the French, they were forced to continue on and pour more resources into its development once they realized the estimates were not as accurate (Henderson, 1977). In industry, not everything is plagued by these convoluted relationships and setups.

While each of these groups appear to be directly impacting the Concorde and its design, each possess unique influences on aspects related to the project. These manufacturers are able to be lumped together as engineering contributors, who each had their own responsibilities and technical deliverables that were made to the project; the main influence each of these had was in their respective expertise and made the plane come together successfully. The relationships, however, are different between the groups mentioned in the previous paragraph: the Board of Directors equivalent viewed this project as one that they could use to advance themselves if it was successful, but were not that devoted to it because they had other obligations with other projects. As such, they created a subcommittee that could focus their efforts more on the Concorde than themselves. This subcommittee was one that could have direct feedback on the Concorde, since this was their priority as a committee rather than one of many like the Board of Directors, but were not the primary decision makers for the project, which made final choices and decisions more difficult to get through the hierarchy. Therefore, the Concorde had many capable groups of people working on accomplishing this difficult task, but had to pass information and choices up through numerous subcommittees and committees/governments who had final say, but were not as invested in the project itself. Utilizing interpretive flexibility, it appears that those who knew the most about the project were less involved in the actual decisions, and those with final say, while they may have been given good options, may have influenced the design based on what they thought and wanted for their own agendas for what would serve their country and motives rather than what would deliver the best product.

The Concorde suffered from many issues and drawbacks once it was completed, all of which led to lessened usage and underperformances in multiple areas. In a look back on its time in the market, Prisco (2018) explains that even though only 20 Concordes were built, people were able to fly on it from 1976 to 2003, but it was plagued by many issues environmentally, technically, and economically that ultimately led to its demise. Back before it began to fly commercially, estimates by its developers said that anywhere from 200 to 250 would sell at a minimum and had hopes of contracts with the US for the future (Burgess, 1973). As is evident today, these estimates were far from actuality, and there were many reasons that it stopped being used. Among those were environmental concerns with its sonic shocks and noise, as well as fuel usage. A study done by Liu (2022) details just how poor its fuel performance was compared to numerous other aircraft over the years; comparing just single-aisle aircraft, the Concorde consumed at least 3 times the fuel of 6 other aircraft when normalized to the distance and passengers carried, with 7 times (700%) the amount of fuel used to the payload carried, with no others exceeding 131% in the category. This enormous use of fuel and its cost, as well as its limited usage in the market made the Concorde unprofitable to operate, and combining this with the noise and difficulty of traveling over land and at airports, its performance took a major decline and ended after 27 years in 2003.

The more modern example of collaboration, Airbus, takes an integrated approach to their engineering projects. Traditional engineering techniques tend to have a sequential order to work being done, which lead to long development time before going to market and inefficient communication among teams. What Airbus has been starting to use is collaborative engineering, where functional and industrial design happens simultaneously and the development time significantly decreases, with the final product being an industrial-grade digital mockup (iDMU) of the product (Mas et al., 2013). By forming these practices early on in the design process, cutting down on development time leads to lower costs and, with improved communication, can have better final designs with inputs by the customer, both of which plagued the Concorde project. Since Airbus is also multinational, each of the countries designated their own national contractor, similar to Concorde, but ensured that their work would be together towards a single design (Hayward, 1987). But what continues to separate Airbus from other collaborative efforts, is that the governments and contractors continue to work together, and push for cooperative success. Despite earlier on disagreements over what the Concorde would serve for them, he governments stood united in the goal that their collaboration would not only bring to market a novel aircraft, but play “an essential part in the internationalization of the aerospace industry and the development of complex economic links.” (Hayward, 1987). Airbus has been centered on this cooperation between teams and members, and the efforts have been felt down to individual projects like the mentioned approach with collaborative engineering.

What this approach does differently from the Concorde is directing the power from those who are less involved in the technical side to those who have a fundamental understanding of the project and can make the best and most informed decisions. While there are executives who run Airbus as a company and decide what projects they should work on, those with technical knowledge are there to choose how the project develops on a smaller scale. In this difference, SCOT tells us that the engineering teams (and contractors, since it’s not all in-house) still are technical contributors to the project, but now have the decision-making power that the Concorde engineers did not possess at the time. As an example of how complicated one of these decisions is, Baalbergen et al. (2022) analyze the collaborative efforts of a different EU-funded engineering tool, and discuss what a decision to adjust the airframe affects. This tool allows for teams in different areas examine trade studies and analyses performed on the current design over time, which ultimately leads to a more productive development phase. In their paper, they say that the changing of one piece affects analysis on performance and cost, which in turn is affected by characteristics of numerous subsystems. Those costs are then managed by system and aircraft manufacturers, certification and regulatory authorities, governments, and airlines. So small changes do trickle down and impact many other areas of the project, and having the knowledge to make fast and informed decisions leads to a less involved design and manufacturing process, and a better overall product.

The change in who is the involved party and has the power to make correct decisions has a massive effect on the outcome and what can be done with the product. With its continued presence in the market, Airbus is making extended efforts to outsource and improve its relationships in new areas and with partners. As Horng (2006) explores, Airbus has formed relationships with the Japanese aerospace industry and was starting to see increased sales in China prior to the 2008 Beijing Olympics, with increasing collaboration starting years prior. While there were difficulties faced in these markets by Airbus, they have pushed to further cooperation beyond just their national sponsors and contractors to new markets, and even have taken hold of a significant portion of the US market. This success by Airbus and the continuation of improved collaboration and integration speak to the efforts made by them and what can be achieved with good project setup and practices.

Conclusion

Through continual advancements and changing of practices towards integration and collaboration, the effect of strong structural setups and the ability to produce successful projects is evident in the comparison between Airbus and the Concorde, both of which share similar backgrounds and technologies across different eras of the aerospace industry. When the French and English created a convoluted and dispersed structure between governments and contractors for their project, the innovation and engineering lacked fluid communication between teams and thus led to underestimates of resources, deadline setbacks, and ultimately poorer performance on the market when it was finished. Whereas the Concorde was poorly structured, Airbus makes continual efforts to improve the collaboration among both their country constituents and contractors, works to further integrate all aspects of their project teams, and are working to further the reach of their massive extent of projects outside of Europe, and are having success at all levels. Some might think that the disparity between the projects and their relative success due to structure is based in the technology gap that exists between the 1960s and 21st century, with the advent of the internet and technologies today that bring together distant groups of people in an instant. But this fails to consider the motives of the people at the time these decisions were made; had the Concorde team made an effort to have a focus on collaboration, they would have made decisions that either utilized existing technologies to facilitate better communication, or setup agreements between parties that allowed for more adjustments made through time as problems occurred or allowed for more cooperation on single aspects of the aircraft.

Within one singular technology, in this case aircraft, there are a plethora of teams that are involved in each aspect of the project, with aircraft being very complex and requiring many different expertise to collaborate and make the finished product. Everything needs to be coordinated and communication between teams for updates, deadlines, and day-to-day collaboration. Setting up projects in certain ways can be conducive or detrimental to this type of work, which is becoming more present in the industry, and can have consequences for the product in the market and usage once completed. Evolving and learning from past projects and understanding their mistakes can lead to improved methods and results for modern applications and products that require this type of collaboration, and this pertains to areas outside of engineering, as well. As evidenced by Airbus' success, recently becoming the world's leading aircraft manufacturer after overtaking Boeing (Allal-Chérif, 2020), and doubling Boeing's deliveries this year, their work in collaboration and integration throughout their company speaks to their proliferation in the world market, having numerous products all perform well, and become a world power in this industry. Using improved communication and strategy in setting up projects, especially for a company with a breadth of products like Airbus, proves to be a more successful way to develop complex and multifaceted designs for the market.

Taking this work further, engineers can take the lessons learned here, analyzing the effects of structure and work between teams, and use that in their own industries. As is evident, collaboration and more integrated approaches to larger projects often lead to more successful products on market, and utilizing those approaches in other areas will lead to similar results. Companies in the industry can take the information presented here and make changes to their current practices, and potentially perform a similar analysis on their previous projects to see if there is a similar trend. Future research into this topic could conduct an analysis in a different field, whether engineering or not, and examine the differences in results across collaboration techniques. Or, to continue with this topic, look into different collaboration approaches and their nuances and make comparisons to those final products and their success on the market. Perhaps this trend only exists at scales similar to airplanes, with numerous teams and contractors on a single project; lowering the scale and project size and performing a similar examination could either confirm what was found here, or lead to differing results. This work would be most useful in the hands of people in industry, whether they are executives or engineers working directly in teams, so they can see the effect that organization and communication can have on the back-end of a project's life; setup has influence on the results of a product.

References

Allal-Chérif, O. (2020, January 17). Airbus again becomes the world's leading aircraft manufacturer. *The Conversation*. http://theconversation.com/airbus-again-becomes-the-worlds-leading-aircraft-manufacturer-129595

Aldridge, J. (2001, October 27). Concorde makeover "puts glamour back in flight" *The Guardian*. https://www.theguardian.com/uk/2001/oct/28/transport.concorde

Aviation: Showing Off the Concorde. (1967, December 15). *Time*. https://content.time.com/time/subscriber/article/0,33009,837626,00.html

Baalbergen, E., Vankan, J., Boggero, L., Bussemaker, J. H., Lefebvre, T., Beijer, B., Bruggeman, A.-L., & Mandorino, M. (2022). Advancing Cross-Organizational Collaboration in Aircraft Development. In *AIAA AVIATION 2022 Forum*. American Institute of Aeronautics and Astronautics. https://doi.org/10.2514/6.2022-4052

Burgess, E. (1973, January 8). Concorde inaugurates the supersonic era. *9th Annual Meeting and Technical Display*. 9th Annual Meeting and Technical Display, Washington, DC, U.S.A. https://doi.org/10.2514/6.1973-16

Candel, S. (2004). Concorde and the Future of Supersonic Transport. *Journal of Propulsion and Power*, *20*(1), 59–68. https://doi.org/10.2514/1.9180

Farah, N. T., Xavier Eidsmore, Abdul. (2019, June 25). Why The Concorde Was Discontinued and Why It Won't Be Coming Back. *The Museum of Flight*. https://blog.museumofflight.org/why-the-concorde-was-discontinued-and-why-it-wont-be-coming-back

Hamilton, J. (1968, October 21). Concorde—An exercise in collaboration. *5th Annual Meeting and Technical Display*. 5th Annual Meeting and Technical Display, Philadelphia, PA, U.S.A. https://doi.org/10.2514/6.1968-990

Hayward, K. (1975). POLITICS AND EUROPEAN AEROSPACE COLLABORATION: THE A300 AIRBUS. *Journal of Common Market Studies*, *14*(4), 354–367.

Hayward, K. (1987). Airbus: Twenty Years of European Collaboration. *International Affairs* (Royal Institute of International Affairs 1944-), 64(1), 11–26. https://doi.org/10.2307/2621491

Henderson, P. D. (1977). Two British Errors: Their Probable Size and Some Possible Lessons. *Oxford Economic Papers*, *29*(2), 159–205.

Horng, T.-C. (2006). *A comparative analysis of supply chain management practices by Boeing and Airbus: Long-term strategic implications* [Thesis, Massachusetts Institute of Technology]. https://dspace.mit.edu/handle/1721.1/38579

Koenig, C., & Thietart, R.-A. (1988). Managers, engineers and government: The emergence of the mutual organization in the European aerospace industry. *Technology in Society*, *10*(1), 45–69. https://doi.org/10.1016/0160-791X(88)90025-5

Latson, J. (2014, September 26). Sept. 26, 1973: A Concorde jet makes its first non-stop flight over the Atlantic. *Time*. https://time.com/3398174/concorde/

Liu, K. H. (2022, June 27). From Concorde's Atrocious Fuel Economy and Demise of Rear-mounted Engines to Future Supersonic Transportation. *AIAA AVIATION 2022 Forum*. AIAA AVIATION 2022 Forum, Chicago, IL & Virtual. https://doi.org/10.2514/6.2022-3314

Mas, F., Menéndez, J. L., Oliva, M., & Ríos, J. (2013). Collaborative Engineering: An Airbus Case Study. *Procedia Engineering*, *63*, 336–345. https://doi.org/10.1016/j.proeng.2013.08.180

Mas, F., Menéndez, J. L., Oliva, M., Ríos, J., Gómez, A., & Olmos, V. (2014). iDMU as the Collaborative Engineering engine: Research experiences in Airbus. *2014 International Conference on Engineering, Technology and Innovation (ICE)*, 1–7. https://doi.org/10.1109/ICE.2014.6871594

Nelson, D. A. (1969). Concorde: International Cooperation in Aviation. *American Journal of Comparative Law*, *17*(3), 452–468.

Pinch, T. J., & Bijker, W. E. (1984). The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other. *Social Studies of Science*, *14*(3), 399–441.

Prisco, J. (n.d.). Revisiting the luxury and glamour of Concorde. *CNN*. Retrieved March 2, 2023, from https://www.cnn.com/style/article/concorde-supersonic-design-lifestyle/index.html