

2021 Ethics in Engineering Case

Gupta Advanced Materials Corporation's breakthroughs in advanced materials has made GAMCO an industry leader. GAMCO's founder, Dr. Amar Gupta, holds several patents for materials that can withstand extreme temperatures and have high structural performance. As a result, GAMCO has become a leading supplier of advanced materials for the rapidly growing hypersonic industry.

Dr. Laura Radcliffe leads 2Strong Engineering (2SE), an additive manufacturing company that has been at the leading edge of building and integrating additive structures. 2SE's designs have been critical in maintaining the integrity of advanced materials, while providing a light and strong product. With their proprietary and patented machines and processes, 2SE is a world leader in printing advanced materials. 2SE's printing capabilities coupled with GAMCO's advanced materials have caught the attention of many aerospace and defense (A&D) companies. Radcliffe and Gupta have been close friends since graduate school and have worked together to disrupt the advanced materials and additive industry beyond military use.

With increasing competitive challenges in the defense industry, Skyward Hypersonic Optimization Technologies (SHOT), a leading A&D company, recently entered the commercial aircraft industry to diversify its operations. SHOT's hypersonic missile defense capabilities have provided the government with cutting-edge solutions, albeit very expensive for the government to continue to fund. Other companies have been effectively designing hypersonic missile defense systems at a fraction of the cost, but their solutions have not met full performance requirements to offset SHOT's competitive advantage.

One of the barriers to entry in the emerging commercial hypersonic market is the need for a longer life expectancy of a hypersonic aircraft compared to missiles. As a result, SHOT must invest more research & development (R&D) funds than initially anticipated. The schedule continues to get more and more condensed, as the R&D funding will soon run out, putting the company in a difficult position.

One of the most critical components of a hypersonic aircraft is its Aircraft Body Shielding (ABS). SHOT subcontracted the ABS development to 2SE based on its exceptional previous program performance with low-life expectancy hypersonic applications. In the contract SHOT required 2SE to partner with GAMCO to integrate their advanced materials with 2SE's cutting-edge manufacturing. The contract called for the production of two units, one for ground testing and the other for flight testing.

2SE started official qualification testing of the ABS. The qualification test plan, approved by SHOT, documented that the ABS will be tested under extreme thermal temperatures, and once complete, will be moved to the vibe chamber to perform rigorous vibration testing. Although sequential testing is standard, Fernando, a new PhD material scientist at 2SE, felt that the standard testing protocol may not be fully representative of the combined temperature and vibration environment the aircraft may face in actual flight. Fernando decided to conduct an ad hoc and unfunded combined thermal and vibration analysis on the ABS. Fernando's analysis identified a potential risk in the combined environment. He theorized that the advanced materials from GAMCO were a hazard to use on the ABS. Fernando quickly communicated this risk to Vincent, the Chief Engineer. Vincent was surprised with Fernando's findings as the 2SE environmental test team recently completed successful thermal testing and then successful vibration testing. Although Fernando's analysis was outside the scope of the contract, Vincent initiated a Root Cause and Corrective Action (RCCA) investigation to determine why the team is seeing discrepancies between the environmental qualification test and Fernando's combined analysis results.

During the RCCA, the 2SE team identified improper heat treatment of the additive part or the raw material as likely causes of the variations in expected values. Radcliffe quickly contacted Gupta to get his company involved in the RCCA process. Gupta was quite frustrated as he thought that 2SE was wasting time looking for trouble since the required test met the specifications, and the project schedule was already constrained as it was. GAMCO shared that they printed a test coupon with the new material on their additive equipment which showed positive test results. Gupta felt that he had to cooperate since 2SE was possibly finger pointing at GAMCO.

At the same time Brianna, a GAMCO ceramic engineer working on the project, analyzed data from previous thermal and vibration tests utilizing 2SE's additive processes with GAMCO materials. She saw that the tests had been at the edge of the outer ranges deemed acceptable, but she was unable to determine if GAMCO had been running tests with the most current passing 2SE data.

Given the pressure of the situation, Brianna didn't express her concerns to her engineering manager as she felt the results were likely still acceptable and she didn't want to bring undue attention to the issue without fully knowing if she was correct. When her leadership pressed for her opinion, she said that everything appeared to be within the specification and the analysis from 2SE was overly conservative.

After being briefed by his engineering leadership, Gupta felt confident that the ceramic advanced materials that his company produces met the advertised specification. He and his material scientists believe the issue identified by Fernando resides with 2SE's new additive manufacturing process and their lack of knowledge of the new material.

2SE's leadership, including Dr. Radcliffe, however, believe GAMCO does not fully understand all the properties of the new material in extreme environments and how the material properties change during the additive manufacturing process. Radcliffe is a highly analytical, risk-averse leader, but she is confident that the problem does not reside within 2SE. She questions how thoroughly GAMCO looked into the issue.

In an attempt to figure out the problem, Radcliffe suggests that they run another round of temperature and vibration testing on the second unit. Like the first test, the ABS used in the testing cannot be delivered to SHOT because the test is deemed destructive and may compromise the integrity of the part, making it not flight worthy. Gupta reminds Radcliffe that they only have one ABS manufactured for delivery so far and the contract states they only need to test one ABS which already successfully passed testing. While GAMCO and 2SE were performing the RCCA, SHOT contacted Radcliffe to relay the customer's request to accelerate the demonstration of the aircraft to verify readiness for future funding. SHOT provided Radcliffe with an aggressive new timeline that put 2SE's ABS on the critical path. 2SE would need to accelerate their schedule to meet the demonstration timeline. Radcliffe told SHOT that they had run into a potential technical risk with the ABS and could not meet the new timeline. SHOT informed Radcliffe that 2SE must deliver on the requested schedule date or SHOT would look for an alternate supplier for future efforts as their delay could significantly impact the hypersonic commercial aircraft program (H-CAP). This would result in SHOT not securing the follow-on funding for H-CAP. As 2SE's largest customer, this could be a major financial setback for the company and would have a significant impact on GAMCO's business as well.

Radcliffe immediately contacted Gupta with the news. Gupta felt that Radcliffe was caving under pressure and was not looking hard enough for ways to meet the new deadline. Gupta requested more information on the customer demonstration to better understand the requirements for the ABS.

Radcliffe shared with Gupta that the H-CAP would not reach hypersonic speeds but would be tested at supersonic speeds and highlighted that the aircraft would be manned for this demonstration.

Gupta and Radcliffe agreed to re-perform Fernando's data analysis on the ABS with the anticipated supersonic constraints for the customer demonstration. Fernando, the material scientist who discovered the potential discrepancy, analyzed the ABS which performed within the specification, but found that it was on the upper edge of the control limit. Fernando highlighted to Radcliffe that even though it was within the defined specification range, other environmental factors could impact the part's performance, and he could not say with certainty that it was safe to fly. Fernando said that if in the demonstration the pilot reached higher speeds than provided by SHOT, then the ABS may experience technical issues and could result in a hard failure.

Radcliffe was not comfortable taking any risk with a manned flight. Even though the ABS showed positive results during lower temperature analysis and passed qualification, she was concerned with the potential failure which could impact the pilot's safety. Gupta, on the other hand, felt he was more adept than Radcliffe in taking informed risks. He was confident with the results in the lower speed requirement, they had met the customer's specs and followed the process. He further reinforced that if they did not meet SHOT's schedule, then both companies would likely incur layoffs and potentially go out of business due to the strategic relationships they have with SHOT.

Gupta and Radcliffe brought their teams back together to come up with a solution. At the end of an inconclusive meeting Gupta turned to the engineers of both companies. "Did the tests meet the customer's requirements? Yes. Is the ABS perfect? No. Can any of you prove to me that it is unsafe for the demonstration to proceed?" There was no response from any of the engineers in the room. Gupta then turned to Radcliffe and said, "See, what did I tell you?"

SHOT's senior program and engineering team have called 2SE and GAMCO's leaders to an emergency meeting to get to the heart of the issue and to determine how the demonstration can go forward.

Your team will be assigned to play the role of either the 2SE team or the GAMCO team at this critical meeting with SHOT's leadership (which will be the role the judges will play in the competition rounds).