The History of Design/Build/Fly at San Diego State University

Jeremy C. Johnson[1], Roberto Marquez[2] and Xiaofeng Liu[3]
San Diego State University, Department of Aerospace Engineering, San Diego, CA,92182

The purpose of this paper is to convey the history of the student team at San Diego State University (SDSU) that competes in the annual AIAA Design/Build/Fly (DBF) competition. The SDSU DBF team was founded in 1997, with the objective of enhancing students' participation and learning experience in major-related extracurricular STEM activities through the design, manufacturing and fly testing of an electric-powered Unmanned Aerial Vehicle (UAV) suited towards competing with fellow teams from other universities in various types of assigned missions. Throughout the past 24 years, many students at SDSU DBF have had the opportunity to learn about aircraft design in a team environment and apply their knowledge gained in the classroom to further the club and the school as a whole. This paper will go over the team's history in a chronological manner, as well as the achievements and contributions. Information presented in this paper was attained by interviewing former members of SDSU DBF, scrutinizing past reports and documents, and using placement information provided by AIAA.

Nomenclature

AIAA	=	American Institute of Aeronautics and Astronautics
DBF	=	Design/Build/Fly
RAC	=	Rated Aircraft Cost
SDSU	=	San Diego State University

Figure 1: The Current Team Logo for Design/Build/Fly at SDSU.

I. Introduction

THE American Institute of Aeronautics and Astronautics (AIAA) Design/Build/Fly (DBF) competition began in 1996 in order for university students around the world to have the opportunity to apply what they have learned in the classroom and gain real-world experience of Aerospace Engineering[1]. The competition revolves around designing and manufacturing an electric-powered, radio-controlled aircraft suited towards a yearly

[1] Undergraduate Student, San Diego State University Department of Aerospace Engineering, AIAA Student Member.
[2] Undergraduate Student, San Diego State University Department of Aerospace Engineering, AIAA Student Member.
[3] Associate Professor, San Diego State University Department of Aerospace Engineering, AIAA Associate Fellow. Email: Xiaofeng.Liu@mail.sdsu.edu.

objective and set of required parameters as assigned by the DBF Organizing Committee at AIAA. The rubrics for evaluation of the competition are traditionally custom-made every year to uniquely complement the objective of that year. In addition, each team must send a detailed design report of their team's aircraft, including design parameters, a detailed drawing packet, and trade studies. This report's score, together with the competition fly score, will contribute to the overall score that each team gets. Since its inception in 1996, the AIAA Design/Build/Fly competition has substantially grown[7], with more schools competing mostly every year, as shown in Figure 2, below.

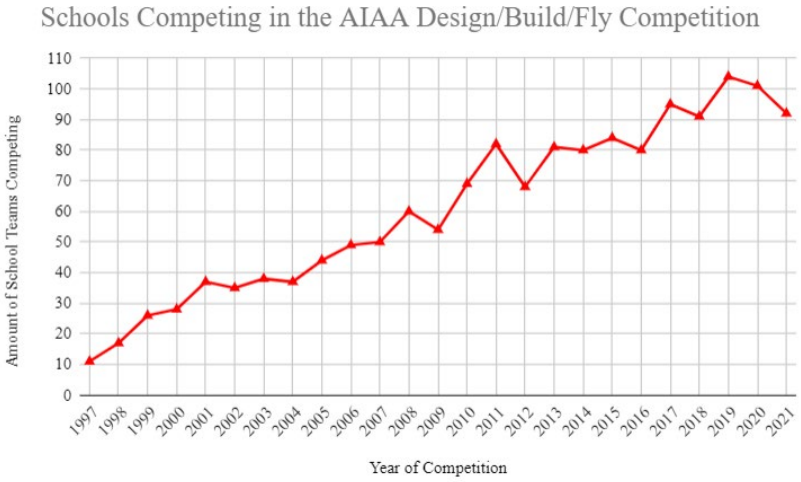


Figure 2: Graphical Representation of the Number of Competing Teams at Each Year's Design/Build/Fly Competition.

Design/Build/Fly at San Diego State University (SDSU DBF) has been competing in the DBF competition since 1997 and offering students at San Diego State University (SDSU) the opportunity to engage in a real-world aerospace environment, learn many aspects of aircraft design and teamwork, and apply their engineering knowledge from the classroom to hands-on objectives[2]. The DBF activities support the growth of the student members and have furthered the team through the years with the knowledge and skills necessary to complement their positions as successful engineers in the aerospace industry. Over the years, SDSU DBF has had the honor of achieving many awards, including the achievement of first place in the 2003 Design/Build/Fly competition[3] and second place in the 2013 competition[4].

SDSU DBF members have various opportunities to work with local aerospace companies. Traditionally, Northrop Grumman aids in the team's design process by participating in a preliminary design review near the early stages of the competition. Here, the student members get the opportunity to receive vital information from experts in the aerospace field curtailed to their current aircraft, and recommendations to make the aircraft the best that it can be. Additionally, this serves as one of the main networking opportunities for SDSU DBF, as the members are able to connect with many engineers and former members of the team.

SDSU DBF has been carried on through cycles of students entering and graduating from the University by student members dedicated to further the team. Executive positions traditionally consist of a Project Manager, Co-Project Manager, Chief Engineer, Treasurer, and Outreach Coordinator. These positions are elected by the entirety of the team after the competition of the previous administration has been finished. The Project Manager serves as the leader of the team and takes the highest responsibility for the team's outcomes, the Co-Project Manager assists the Project Manager and oversees the state of the project, the Treasurer manages the financial affairs of the team, the Chief Engineer oversees and supervises the technical design of the aircraft and manufacturing, and the Outreach Coordinator is responsible for coordinating the public relations and events at SDSU. Appointed officials are team leads appointed by the Project Manager for specific responsibilities. The roles in this category are subject to change each year depending on what is deemed necessary for the competition, but the roles traditionally consist of a Structures Lead, the Aerodynamics Lead, the Propulsions Lead, and the Systems Lead. The Structures Lead conducts structural and material analysis for the design of the aircraft, the Aerodynamics Lead designs optimal airfoils, wing platform and aircraft configuration to ensure the quality of aerodynamic performance and flight stability, the Propulsions Lead selects the optimal motor and electronics to be used in the aircraft, and the Systems Lead supervises the design of the

year-specific objective mechanisms determined by each competition. The team also has a professor that presides as the advisor, who assists the team and provides insight on the engineering process every step of the way. By designing, building, and eventually flying aircraft, SDSU DBF has been empowering generations of engineers to thrive in their fields for almost a quarter of a century. Both the AIAA DBF competition and the SDSU's team have greatly contributed to the learning experience of aspiring engineers over the years, which makes the history worth sharing.

This paper mainly relied on uncovering contact information and interviewing former members, scrutinizing and searching for former photos, documents, and videos, and using scoring information provided by AIAA. An Overview Timeline for the history of SDSU DBF is shown on Figure 3. This paper documents the history of the SDSU DBF team in a chronological manner and the team's impact at SDSU, displays many of the team's achievements and the aircrafts built, and highlights how SDSU DBF has helped the former members get where they are today.

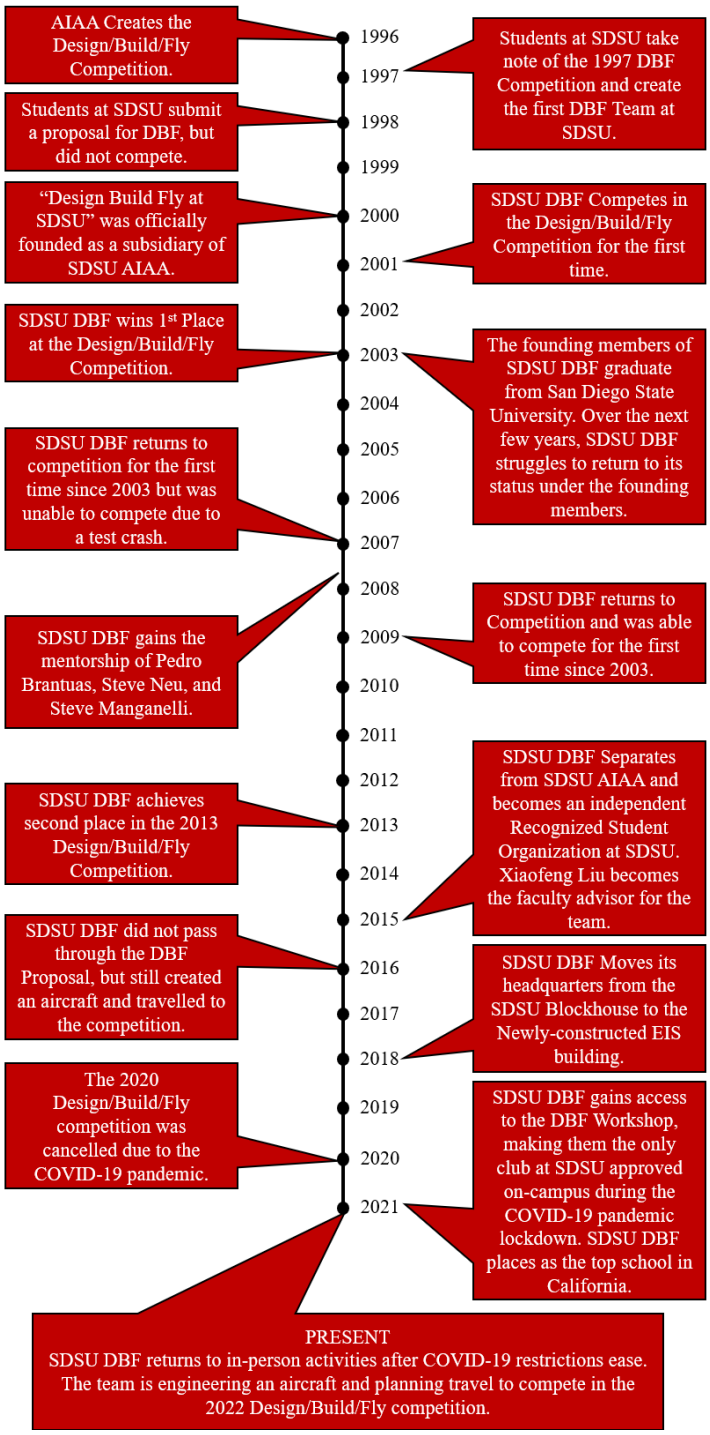


Figure 3: Overview Timeline for the history of Design/Build/Fly at San Diego State University.

II. The Early Years

In 1996, the AIAA Applied Aerodynamics, Aircraft Design, and Flight Test Technical Committee founded the Design/Build/Fly competition[1]. This competition served to provide university students aspiring to enter the aerospace industry the opportunity to apply their analytic studies to a hands-on competition for unmanned aircraft. Every year, student teams from universities around the world will compete to design and fabricate an aircraft to optimally perform the annually changing objectives. The first competition was held in Maryland in 1997, where eleven schools took part. Students at San Diego State University took notice of the newfound aircraft competition, and conversations were beginning to take place on the university getting to work on an aircraft.

The first team to take part in Design/Build/Fly was formed in 1997 after the first competition was finished. Víctor Hugo, the student chapter president of the AIAA SDSU branch, led a team to develop an aircraft. This year, the team needed to create an aircraft capable of carrying 7.5 pounds of steel and complete a maximum number of laps in 7 minutes. A canard aircraft was engineered to hold the cargo, but the team struggled finding the optimal center of gravity for a canard configuration. An aircraft was able to be created in the end, but the team was unable to travel to Wichita to compete in the 1998 competition, thus was placed

solely on the design report score. However, this team opened the door to San Diego State University being involved in the Design/Build/Fly competition.

For the next two years, no official team submitted any intent to compete in Design/Build/Fly. Even though no team took part these years, competing remained a hot topic among SDSU aerospace engineering students, especially in the AIAA branch. It became apparent from Hugo's experience that if a team shall compete, financial backing and resources would be necessary. It wasn't until the Fall of 2000 that members of the AIAA Chapter at San Diego State University acted on the talks of taking part in the Design Build Fly competition. This group of students, with the assistance of the SDSU Department of Aerospace Engineering and Dr. Joseph Katz, a professor at San Diego State University, gathered a list of SDSU alumni for a donation list. It was determined that if SDSU was to have a presence at the 2001 Design Build Fly competition, financial backing would be vital. This strategy proved to be successful. The team, which was under SDSU AIAA at the time, earned thousands of dollars from that effort. However, in early 2001, the development of the competition aircraft ceased, as the students that originally led the effort had difficulty in the progress of the project.

Chad Berman, President of the SDSU AIAA Branch, stepped into the Design Build Fly project to ensure that the team goes to competition and that the team would keep their word with the donors who helped fund the dream of competing in Design Build Fly. Even though there was involvement from SDSU in the 1998 competition, this served as the founding of the organization that would become SDSU DBF. Berman gathered other SDSU students that he believed capable of completing the aircraft and competing, such as Andy Bechtel, Greg Marien, Tim Lo, and more. At this time, the design report was only a couple of months from being due, so Berman and the newly-found SDSU DBF Team would need to dedicate their time to completing the project in the timely manner. According to Chad, the resulting aircraft, known as *Full Monty,* "left much to be desired" utilizing a carbon fiber cylindrical fuselage and foam wings. Berman referred to this year as the "practice round" which gave the team experience in the engineering process of the aircraft and lessons to be learned. Eventually, the team was able to complete *Full Monty* and compete in Maryland placing 20th place in the 2001 competition. What this small team of dedicated engineering students did not realize, however, was this project that they refused to have left unfinished would become one of the principal clubs of the SDSU Department of Aerospace Engineering for decades to come.

Figure 4: Aerial photograph of the 2001 SDSU DBF competition aircraft, *Full Monty*, competing in the 2001 Design/Build/Fly Competition.

After this year, the SDSU DBF Project gained interest around the school as a subsidiary of the SDSU AIAA Chapter. In addition to hosting events with industry professionals, competitions, and group tours of nearby aerospace companies, the SDSU AIAA Chapter would facilitate the school's Design Build Fly team. The involvement in DBF became well known throughout the Aerospace Engineering Department of SDSU, of which was much smaller than now in 2021. Berman remained invested in the DBF team, assisting in the design and development of the aircraft for the 2002 competition, with Greg Marien taking the lead as Project Manager. This year, the team used the experience and school excitement from the previous competition to hit the ground running with the aircraft. In addition, the members that went to the Maryland competition prior were able to observe the competing schools' creations, realizing the extreme level of competition. At SDSU, George "Captain" Faulkner, an influential Aerospace Engineering professor with connections at Northrop Grumman, took notice of the progress that SDSU DBF has been making. After talks with these Northrop engineers, Faulkner was able to get the Northrop employees to provide a tour and meet SDSU DBF. The engineers at Northrop Grumman were impressed, and SDSU DBF received an offer to formally present their design as a Preliminary Design Review at the San Diego Northrop Grumman facility and were awarded with the team's first industry sponsorship. This would begin an annual tradition for years to come (with Marien eventually going to work for Northrop Grumman after graduation and move to the receiving end of these Preliminary Design Reviews).

Once again, the team were able to travel to the competition with their new creation, *Monty's Revenge.* According to Greg Marien, *Monty's Revenge* was so heavy that it weighed well over thirty pounds with a wingspan of over nine

feet. However, due to extremely windy conditions at the 2002 Design/Build/Fly competition in Wichita, Kansas, SDSU DBF's aircraft, being overweight, helped with gust alleviation and made it a very stable aircraft compared to others. With much more time and establishment, the team managed to excel in the 2002 competition in Wichita, Kansas, achieving sixth place.

According to Chad Berman, the aircraft created to compete in 2002 was a winning aircraft, but the team did not yet understand the science of technical report writing. The report score works as a multiplier for the flight scores in the Design/Build/Fly competition, so the effort put into the report can make or break a team. Taking the report as a fundamental part of the competition would be implemented in the next competition, with successful results. For the third year of SDSU DBF's involvement in the Design Build Fly competition, Greg Marien reprised his role as Project Manager to develop from the momentum of the two previous years' placements. The team was in a great position, thanks to the previous two years of experience and financial backing from Northrop Grumman. Marien and the team broke down the criteria of the report requirements and used those to write their technical report, which they further utilized as insight on development for the aircraft itself. This focus on writing proved to benefit the team, as SDSU DBF had a score of 84.5 for their report. However, the report was not the only aspect that led the team to victory, as they made major allocations to the design and fabrication of their aircraft.

Figure 5: Members of the 2001-2002 SDSU DBF Team after a late-night manufacturing session for *Monty's Revenge.*

Figure 6: Members of the 2002-2003 SDSU DBF Team discussing *the Spirit of Monty*'s preliminary design.

SDSU DBF's 2003 competition aircraft, otherwise known as *the Spirit of Monty*, left the other schools in the dust. However, development of the aircraft had its own issues. At one of the test flights, an engineer at Northrop Grumman was observing the performance of the aircraft, adding to the pressure for the team to succeed in this test. Unfortunately, the removable landing gear was too flexible, allowing the aircraft to experience too much downward bending, where the payload would scrape on the floor. Members wanted to introduce metal rods lining the landing gear to "get it in the air" but Marien was concerned with the implications of introducing rigid bodies to the system. Despite the team's excitement and an influential member of Northrop Grumman observing, Marien made the tough decision to cancel the test flight and add more layers of carbon fiber to the landing gear in concerns that the dramatic change would change many variables, risking a crash of the aircraft. It turned out that adding more layers of carbon fiber to the landing gear indeed improved its performance substantially. Examples like this furthered and ultimately improved the aircraft until the aircraft was ready to be flown at the competition. At the 2003 competition in Ridgely Maryland, where SDSU DBF members needed to "put their skin in the game" and pay for their own travel expenses to the competition, *the Spirit of Monty* earned a flight score of 1.16, with the closest to that being 1.09. Due to the combination of having the highest flight score and a solid report score, SDSU DBF received first place in the 2003 competition.

After recalling many of the events that happened during his time as the Project Manager of SDSU DBF, Marien had the following to say about one of the contributing factors to victory:

> "It took three years to win the competition. The most important factor to winning the (Design/Build/Fly) competition is that you have got to have that legacy of knowledge going from year to year… The first year, we didn't have any knowledge of making an airplane. We were able to make the wings work and many 'engineering

> decisions' and created what I maintain to be the ugliest looking plane in the world. We fixed that the next year (in the 2002 competition) when we came in with a beautiful looking plane. We never worried about weight… so, you can imagine how much that hurt us in the rated aircraft costs and flight performance. In 2002, when the
>
> had to concentrate on weight more. Early on, we put a lot of thought into designing the aircraft to win… and put plenty of focus into the Rated Aircraft Cost and how it will perform in factors that relate to the scoring. That's what really won the competition and the key factors of the process of getting there."

After winning the 2003 Design/Build/Fly competition, the time came for many of the core members of SDSU DBF to graduate and begin their careers in the Aerospace industry. This meant that the time came for Chad Berman, Greg Marien, Tim Lo, Andy Bechtel, and more of the members that formed the organized SDSU DBF team to pass the team on to future generations. Since the first student team submitted an intent to compete for the 1998 Design/Build/Fly Competition, SDSU DBF was able to grow from a collection of students working on an aircraft and searching for funding, to an established team at San Diego State University, which would prove to enrich students for many years to come.

Figure 7: Group photo of the 2002-2003 SDSU DBF Team by the San Diego State University Engineering Building, after returning from winning the 2003 Design/Build/Fly Competition in Ridgely, Maryland.

III. Rise, Fall, and Rise Again

After Marien, Berman, Lo, Bechtel, and others graduated from San Diego State University, it was up to the few members who were not seniors to carry the torch of the team's growth. During the development of *the Spirit of Monty*, Marien tried to train his successor who would take the mantle of Project Manager. Unfortunately, the new team had a tough time carrying SDSU DBF after the graduations. In addition, the new team were running into similar problems with regard to scheduling and time commitment that the beginning years were, and were ultimately unable to compete in the 2004 Design/Build/Fly competition.

Disappointed by the sudden drop in SDSU DBF's scores from first place to being unable to compete, some members left, and some remained, motivated to keep the team's reputation going. Don Myers stepped up to the role of Project Manager to get SDSU DBF back to competing shape. The team was accepted to compete in the 2005

competition, thus going full-steam-head with *Monty's Pride,* the anticipated successor to previous SDSU DBF aircraft. Unfortunately, the team was ultimately unable to travel to Maryland to compete in the 2005 competition. However, the team received a design report score of 84.25 and a solid Rated Aircraft Cost of 9.87, showing that they did push themselves to bring SDSU DBF back onto the scoreboard. At the end of the day, the design report and Rated Aircraft cost were able to earn SDSU DBF 25th place out of 44 competing teams.

Figure 8: The 2006-2007 SDSU DBF Team in a Tucson, Arizona parking lot before the 2007 competition.

SDSU DBF was back in shape to compete in the Design/Build/Fly competition, and Myers reprised his role as Project Manager to build off of the momentum that the team made in the 2005 competition. The team again was approved to compete in the 2006 competition but were unable to travel to the competition itself. The team still developed an aircraft known as *Monty Python* but received a slightly lower report score than the previous year: 79.05. In addition to that, Design/Build/Fly has been substantially growing and becoming well-known among university engineering students. Due to this, many more teams competed in the competition, making being unable to compete cost SDSU DBF more placements. At the end, SDSU DBF placed 41st Place, out of 49 teams.

Over the span of the next few years, SDSU DBF was slowly but surely improving and building back to the glory days. In the 2007 Competition, SDSU DBF's *The Spirit of Monty II* earned 27th place out of 50 teams. This year marked the first time that SDSU DBF was able to return to compete in the physical Design/Build/Fly competition, held in Tucson, Arizona this year. *The Spirit of Monty II* was able to pass the preliminary technical inspection and able to compete in the Ground Mission, and the team was excited to get the aircraft competing in the air. Unfortunately, a large error occurred when the team was test flying before the first mission. SDSU DBF was attempting to test fly *The Spirit of Monty II* in the dirt, and were becoming frustrated due to the insufficient ground controls. Thus, the team decided to take the aircraft to an asphalt side road in the outskirts of Tucson, Arizona, where they unfortunately crashed the aircraft into a barbed-wire fence. The barbed-wire punctured the wings and lower section of the aircraft, making SDSU DBF unable to compete for the rest of the competition. Although SDSU DBF was unable to compete in the missions of the competition itself, this marked the first time that the team was able to travel to the competition since *The Spirit of Monty I* back in 2003, signifying the team's slow but steady return to former glory.

Figure 9: One of the wing punctures from barbed wire, eliminating SDSU DBF from the 2007 competition due to inability to fly.

The following year, SDSU DBF returned to the workshop and earned 39th out of 60 with *the Aztec*. *The Aztec* was the team's first aircraft to not reference *Montezuma*, the ninth emperor of the Aztecs. However, the aircraft still referenced the Aztecs, the official mascot for San Diego State University. One of the major pieces of history to happen in this time was the beginning of many influential mentors to SDSU DBF: Pedro Brantuas, Steve Neu, and Steve Manganelli. Brantuas, a professional pilot and engineer, aided in the development of many team's aircraft and served as SDSU DBF's pilot for years to come. Steve Neu and Manganelli, commonly referred to as "the Steves", served as an influential duo that previously assisted the University of California San Diego (UCSD) DBF's team. Neu, the

founder of Neumotors (an R.C. aircraft motor and avionics company) gave advice on the team's aircraft propulsion systems. Manganelli, former NAVAIR engineer and Design/Build/Fly enthusiast, assisted SDSU DBF with RC Aircraft design and manufacturing, and the structure of the DBF competition as a whole.

Project Manager Guinness Helfrick led the team to engineer the *B.A.M.*, which was the DBF aircraft to satisfy AIAA's mission objectives of carrying 4-liter fuel tanks filled with water, and model rockets. After competing in the 2009 competition in Tucson, Arizona, SDSU DBF earned a placement of 15 out of 54 teams. This was both the first time SDSU DBF was able to compete in the physical Design/Build/Fly competition, and also the first time that SDSU DBF broke into the top 20th percentile since *Monty's Revenge*, six years prior. The 2009 SDSU DBF team and the *B.A.M.* proved that the team has at last recovered from the original team's graduation (it must be noted that Greg Marien, now at Northrop Grumman, has been supporting SDSU DBF with advice every year and in the annual Northrop Grumman Preliminary Design Review) and that SDSU DBF was ready to continue being among the top contenders in the Design/Build/Fly competition.

Figure 10: The 2008-2009 SDSU DBF Team at the Design/Build/Fly Competition in Tucson, Arizona.

Figure 11: The 2009-2010 SDSU DBF Team in front of Northrop Grumman's San Diego Facility, after the annual Northrop Grumman Preliminary Design Review.

After this return to the physical competition, SDSU DBF was eager to build off of the past few years of momentum and bring home the gold once more. Led by Monique Fine, the team built off of previous years' experience and assistance from Brantuas, Neu, Manganelli, and Marien, SDSU DBF created *Monty's LN-7* to compete in the 2010 competition, which required aircraft to carry baseball bats and softballs. SDSU DBF was able to fully engineer their aircraft, but in a final test flight, the wings snapped and *Monty's LN-7* fell down into Mission Bay in San Diego, California. The team worked to the best of their abilities to rebuild the aircraft, and drove it overnight to Wichita, Kansas, for the 2010 competition. Despite the setback, SDSU DBF had a solid aircraft that other teams feared. When in a conversation with Greg Marien, who went with SDSU DBF to Kansas for the competition, described Fine & Co.'s aircraft with praise:

> "Her team had a winning plane, a very high report score, and a great Rated Aircraft Cost. This thing was a speed demon and would have won the competition. The first time they flew, everyone was like 'San Diego State has got this in the bag'. This thing was flying at 60 knots throughout the course and it was light."

However, one slight error kept the team away from first place. When assembling the aircraft for Mission 3 at competition, the servos were incorrectly plugged into the aircraft's receiver, causing *Monty's LN-7* to be uncontrollable. Due to this, the pilot was unable to fly the aircraft and SDSU DBF received a zero for Mission 3. However, the team performed so well in the other missions, report score, and Rated Aircraft Cost that they were still able to finish in 23rd place out of 69 teams.

After this competition, James Hroza was elected to serve as the Project Manager of SDSU DBF's 2010-2011 term. Despite the unfortunate circumstances, *Monty's LN-7* proved that SDSU DBF was capable of creating a winning aircraft, and current members, including new SDSU DBF member Jeromey Suko, mentioned later, would gain experience from. This year, the team designed and built *Monty's Bayfinder*, which was also a solid aircraft that met

unfortunate circumstances. During the second mission of the 2011 Design/Build/Fly competition in Tucson, Arizona, SDSU DBF's aircraft crashed and was unable to compete in both missions 2 and 3, receiving a zero for each. Despite this, SDSU DBF was still able to earn 43rd place out of 82 competing teams due to *Monty's Bayfinder*'s Rated Aircraft Cost, Mission 1 passage, and report score.

Mathew Hager-Tompkins served as the Project Manager for the 2011-2012 term of SDSU DBF. The team was eager to learn and implement new manufacturing technologies, with the most notable example being creating female molds for the aircraft's fuselage from aluminum blocks and a CNC machine, and using that to use bladder-mold layup technology to fabricate a sturdy, smooth fuselage. The team would then develop the aircraft and head to Kansas for the 2012 Design/Build/Fly competition, where an unexpected force of nature affected them. While in their hotel, a tornado began outside and forced the team to take refuge. The team ended up earning 25th place, but future members of SDSU DBF would refer to this as the "tornado year".

The 2012-2013 term of SDSU DBF is known as one of the most successful years in SDSU DBF history, as the team was able to earn second place out of 81 teams. Led by Project Manager Jeromey Suko, Junior, the team was able to engineer a top-performing aircraft by trusting the iterative engineering process and collecting raw data from real-time experiments. A large focus of the year was advancing manufacturing techniques, superseding the manufacturing technologies from the previous year. The team was able to acquire many sponsorships, such as Northrop Grumman and Quatro Composites, who taught many manufacturing techniques including forced pressure bladder molding for composites. In addition, SDSU DBF acquired a CNC hotwire Foam cutting machine, which used a hot wire to cut blocks of foam to create wings with accurate airfoils.

In order to create a successful aircraft, Suko also pointed to the rigorous testing procedure that the team followed. As Jeromey puts it:

> "The biggest thing for us was test flights. We obviously did back-of-the-napkin analysis early on to figure out the platform size area for wing tail size, general shape, and weight. And we obviously knew by the RAC (Explained in section VI) and missions, how much weight the plane had to carry, so that's how we decided everything, and focused mostly on prototyping and flying. I think we flew our first prototype in the first week of October, so we hit the ground running and just flew hard. Basically, what we did early on, was just mockup the shape of the fuselage with foam and put a little bit of fiberglass and carbon fiber on it to reinforce it in some spots, get the general wheel placement, just general design when you're going to do a taildragger. Then, we got out there with prototypes and flew as much as we could because we'd seen so many past years where they were flying for the first time, like a month before the competition. You can do a lot of analysis, but the most important thing to do for us was to get out there and fly."

This ambition towards creating flyable prototypes quickly and extracting real-time data resulted in the team having a well-rounded aircraft with attention taken to every detail. Throughout making three prototypes, SDSU DBF was able to receive flight input about the aircraft's stability troubles and thus, adjust the biplane wings to perfect through iteration. By the time most teams were putting their aircrafts in the air for the first time, Suko and his team already had their competition aircraft fool-proof and were ready to prepare for competition.

Figure 12: Members from the 2012-2013 Team after successfully developing a Bladder-Molded Carbon Fiber Fuselage for the 2013 competition aircraft.

According to Suko, one of the main challenges the team faced in the 2012-2013 term was balancing time between the classroom and the DBF workshop. This balance issue was especially seen during times of exams, where the team was limited to sparse amounts of "free time" to dedicate to the development of the competition aircraft. This proved to be a test of the team's resolve, as Suko explained:

> "Bearing down, getting in there, and grinding it out during those tough periods… Basically, it was just grit and bear and buckling through the hard times. And when you weren't studying for a test, it was spending time in the lab building stuff. And when it wasn't spending time in the lab building stuff, it was trying to get out for test flights. Basically, every waking moment was either DBF, homework, or studying for a test."

On nights that the team had to stay late manufacturing and were forced to leave San Diego State University due to parking enforcement issuing parking tickets after 1:00 AM, the team drove to Suko's home and continued building the aircraft in his garage until sunrise. Despite these harsh time constraints and all-nighters, the team pushed through and was able to finish their aircraft.

These struggles greatly paid off when the team was able to bring their aircraft to the 2013 Design/Build/Fly competition. At the competition, the aircraft was able to fly extraordinarily fast compared to the other school's aircrafts, achieving speeds up to 80 miles per hour. This was due to the team's design focus on raw speed, and Pedro Brantuas, the team's pilot, prioritizing speed when flying in Arizona.

At the Design/Build/Fly awards ceremony after the competition, the hard work, testing, and dedication that SDSU DBF poured into their aircraft paid off as the team was able to earn the silver trophy. This was the second-best place that SDSU DBF has ever accomplished (with the best being first place, 10 years prior) and the best that the team has placed in over eighteen years at the time of this writing. SDSU DBF at last fully regained its reputation as one of the top-competing teams in the Design/Build/Fly competition.

Figure 13: SDSU DBF celebrating after winning second place in the 2013 Design/Build/Fly Competition in Tucson, Arizona.

In April 2013, Terry Ngo was elected to serve as the Project Manager for the 2013-2014 term. Being the Manufacturing Lead in 2012-2013 when SDSU DBF earned second place, Ngo and his team were prepared to continue the legacy brought from the previous year. Continuing the legacy of late-night manufacturing sessions, the team was able to manufacture both a prototype and the final plane, themed as a "Bush plane" (explained further in section V). However, upon reflecting on some of the hardships facing the team this year, Ngo explained how managing time between the DBF team and Senior Aerospace Engineering classes was much easier said than done. The team had trouble creating a system to secure the payload for the year's objective and eventually made a solution using tape. Additionally, he stressed the importance to the current student body of SDSU DBF of focusing greatly on the design report. Inversely, Ngo explained how what he learned through DBF helped him throughout his classes, and vice versa. Even though balancing the competition and class is a harsh schedule adjustment act, it will result in the students learning far more than only classes.

In April 2014, the Design/Build/Fly competition was held in Wichita, Kansas, and SDSU DBF was among the contestants. Here, it is well known to have unexpected gusts of wind, which Ngo described as "able to make the planes VTOL (Vertical Take Off & Landing)". All eyes were on the plane as many were concerned about the payload breaking out. Fortunately, the plane performed as designed and excelled in the competition. When all was said and done, SDSU DBF placed 8th place out of 80 competing schools, placing them as the fourth best scoring team in the team's history.

Figure 14: Members from the 2013-2014 Team Showcasing the Competition Plane's Horizontal Stabilizer.

After the 2014 competition, design lead Christopher Long took the position of Project Manager for the 2014-2015 term. Having served as the design lead the previous year, Long was more than capable of leading the SDSU DBF to great heights. The mission assigned to this year was not anything out of the ordinary, it was a "Remote Sensor Delivery and Drop System". It involved the standard ground mission, proof of flight, payload flight, and deployment flight. Unexpectedly, the philosophy behind SDSU DBF shifted, instead of the gung-ho team that was developing over the past two years, Long's decisions lead DBF to a more collaborative workspace. Being a senior that he was, it dawned on Long that he has the ability to open the door of the aerospace industry to the members of his team. Having spent the past six years reflecting on his spell as Project Manager, Long came to the conclusion that his managerial approach to DBF was a reason as to why SDSU DBF saw a drop-in performance. The team was very well endowed from a technical standpoint, but would decide to focus their efforts in involving new members in the design processes, as well as allow networking opportunities with recognizable aerospace companies located in San Diego. Long's final remarks went along the lines of, learning how to balance the diverse personalities of the group and to stay focused on the objective of that year.

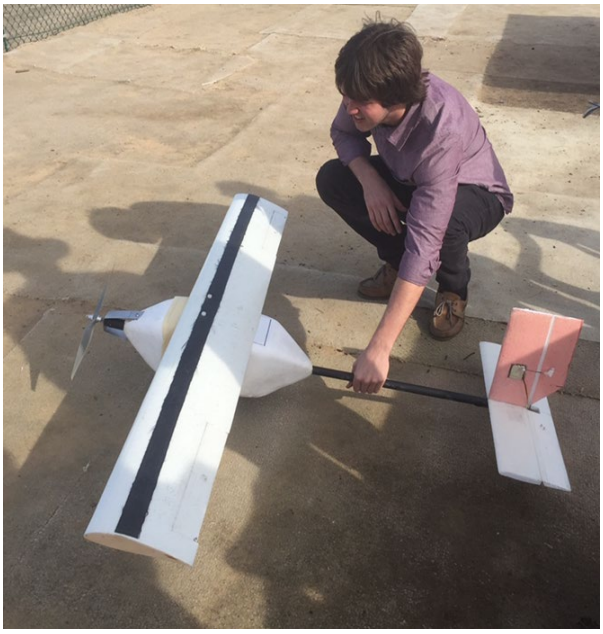


Figure 15: Project Manager Chris Long holding the first prototype of the 2014-2015 aircraft.

The 2015 Design/Build/Fly competition was held in Tucson, Arizona, and SDSU DBF was one of the participants. One of the setbacks SDSU faced this year was the repair process the aircraft had to undergo. This added unaccounted weight and led to a decrease in performance. SDSU DBF managed 21st out of 84 schools, putting the team at the 25th percentile; A result that contributed to SDSU DBF's consistent placement and was a great performance nonetheless.

If any moment could be used to transition the stages of SDSU DBF from "the early days" to "modern days", it could be thanks to one document. On July 6th, 2015, newly elected Project Manager Dorian Andersen, along with Dylan Lauber (treasurer) and Marlon Gerson (co-project manager), submitted a proposal to the SDSU Department of Aerospace Engineering requesting SDSU DBF to become an independent Recognized Student Organization (RSO). Before this, SDSU DBF has operated as a subsidiary team under the AIAA SDSU branch. At first, this structure worked moderately well for both clubs, but as SDSU DBF grew and thus looked to higher project budgets, turbulence came with the structure. The reasons inspiring the split-off in July 2015 included the hassle for both SDSU DBF and SDSU AIAA to share the same bank account with the school and complications in scheduling meetings due to SDSU AIAA managing DBF's finances and scheduling. As an RSO, SDSU DBF would enjoy its own banking accounts under the school for sponsorships and would be awarded with one SDSU professor who shall serve as the team's faculty advisor.

After consideration, Andersen made the call to nominate Dr. Xiaofeng Liu, SDSU professor specializing in aerodynamics and experimental fluid dynamics, as the team's faculty advisor. Other nominations included Greg Marien, SDSU Aerospace Engineering aircraft design professor, former SDSU DBF Project Manager, and Northrop Grumman engineer, Dr. Satchi Venkataraman, professor in aerospace structures, and Dr. Allen Plotkin, professor

specializing in aerodynamics, in case Dr. Liu rejected the nomination. Liu accepted the nomination and on July 14 2015, SDSU DBF became an RSO independent from SDSU AIAA and gained the insight and knowledge of a faculty advisor to support the team for years to come.

IV. Modern-Day SDSU DBF

SDSU DBF was now its own independent student organization at San Diego State University where it received its own banking account, official academic advisor, and seat in the SDSU College of Engineering Student Council. After spearheading this transition, Dorian Andersen was ready to lead his team to the 2016 Design/Build/Fly competition. Unfortunately, that year was one of the few where the team was not able to compete. As Andersen puts it:

> "My team was not able to compete. Unfortunately, the report kind of set us back from being able to compete, but we did go. We designed a pretty amazing plane, probably top five. But we were still able to go to competition and get that experience during my year as well."

Despite the team not qualifying to officially compete, Andersen and his team were still devoted to designing and flying a competition-worthy, which Anderson himself puts as "a top five performing plane". The unique challenge that Anderson's team had to face was to design a plane with minimal sub-assemblies. The team opted for a blended wing aircraft, which in and of itself provides several challenges, one of which being the static stability. Having a non-conventional design, it was crucial that they tested and analyzed every aspect of their plane before going forward, with propulsions and landing gear being two of the most tested components, as Andersen recalled:

> "Propulsions testing is fun and it looks cool, you're revving up your RC motor and pulling like 20 Amps and measuring how much load you're pulling, you're in the wind tunnel so that in and of itself is very cool. Also landing gear testing, going into the structures lab, putting it under stress seeing it buckle and then modifying it accordingly."

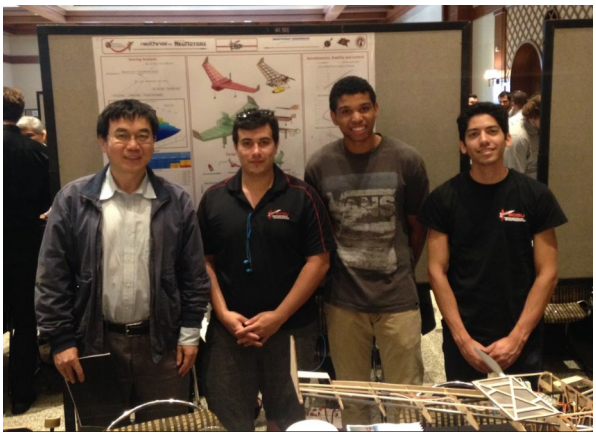


Figure 16: Photograph of SDSU DBF members presenting their year's work to San Diego State University. From left to right: Xiaofeng Liu, Dorian Andersen, Julian Johnson and Javier Navarro.

By the end of that year's competition, Anderson and his team went to competition despite not qualifying and managed to experience DBF to its fullest. SDSU DBF persisted and created a competition worthy plane, created a design report, and even travelled to Wichita Kansas to witness the 2016 Design/Build/Fly competition. This resolve defines the soul of SDSU DBF and each member's dedication to provide a full learning experience for all members, regardless of if any reward is in sight or not.

From 2016 to 2017, Nick Fritzler, Junior, led the SDSU Design Build Fly team as Project Manager to earn 35th place at the Design Build Fly competition. This year, in order to engineer a plane capable of holding hockey pucks and fitting through a tube (as explained in Section VII), many problems were required to be solved through the iteration process, eventually creating an optimized plane. As Fritzler puts it:

> "Obviously, figuring out how to stow an airplane inside of a tube is not as easy as it looks, so you got to do a little bit more engineering and you have to know basic principles in order to make that happen and then make sure that what you're designing doesn't have any flaws. I know that we had multiple design flaws just leading up to competition, but one great way to learn is just by building things and iterating on top of those decisions, and I think we did a really good job at doing that. Eventually, we got rid of all those flaws that were not so noticeable in the beginning, but then, when you learn more about it in courses, you know better, depending on what materials you use then that's when you go back and change, you know those flaws for more improvements."

One main strategy for the 2016-17 plane was to implement an iterative process in order to solve design issues pointed out within each prototype plane. The main problem with this year was deciding how to implement a wing configuration capable of being stowed. Some such examples were keeping the incidence angles of the wings stable in a folding mechanism and considering the manufacturability of the plane. The team ended up moving forward with a twisting wing mechanism to stow the wings parallel with the fuselage. This, according to Fritzler, made the design much simpler and more manufacturable. In regards to designs for internal systems for SDSU DBF Aircraft, Fritzler "highly recommends that [future teams] keep [the design] as simple as you can and make sure that the plane and its components are manufacturable".

Figure 17: Photograph of the 2017 team repairing the competition plane in their Tucson Arizona hotel after the Mission 3 crash.

In April 2017, the 23 members that traveled to Arizona were highly motivated to excel in the Design Build Fly Competition and succeeded in the first two missions. However, in the third mission, which involved throwing the plane by hand to take off, an unexpected crosswind made the throwing unstable and resulted in the plane crashing. The Team spent all night to repair the plane in the budget Tucson hotel, eventually repairing all damaged parts of the plane, making it eligible to fly once again. The next day, the team repeated mission 3 and excelled. By the end of the 2017 competition, SDSU DBF was awarded 35th place.

Figure 18: Photograph of the 2016-2017 SDSU DBF Team at the 2017 Design/Build/Fly Competition in Tucson, Arizona.

In January 2018, San Diego State University finished the construction of the Engineering & Interdisciplinary Sciences (EIS) building, which would be the new home of SDSU DBF. Figure 19 shows the new SDSU DBF Workshop in the EIS Building. This move, under the leadership of Project Manager Ben While, Co-Project Manager Nick Fritzler, and Faculty Advisor Xiaofeng Liu, required all tools, equipment, and manufacturing materials to be transported from the Blockhouse to the EIS workshop. This move resulted in the team having more room to engineer ambitious aircraft for future Design/Build/Fly competitions.

Figure 19: Photograph of the new SDSU DBF workshop in the Engineering & Interdisciplinary Sciences Building, photographed September 17, 2021.

Unfortunately, the team suffered from some turbulence after this relocation. In the 2017-2018 term, SDSU DBF was unable to get the design proposal accepted by AIAA, and thus was unable to compete in the 2018 Design/Build/Fly competition. In order to keep morale high despite being unable to compete, Project Manager Ben While made the decision to continue designing and building aircraft for the sake of teaching all of the members at the time so the team may live on. The team would focus on a more educational schedule this year, having many smaller aircraft designing projects to teach the members about design, aerodynamics, manufacturing techniques, and much more. This would result in the next members taking the mantle of SDSU DBF executive members having the experience needed to get back in the game for the next year. In addition to the engineering experience that prevailed, the SDSU DBF Workshop moved locations. Nick Fritzler, Co-Project Manager of the 2017-18 SDSU DBF Team, explained that one main focus this year was to move all equipment owned by the team from the old location, known as the "Blockhouse" to where it currently resides today, inside SDSU's Engineering & Interdisciplinary Sciences building.

During the 2018-2019 term, Julian Johnson was elected as Project Manager during his fourth year as a member of the team. Once he became Project Manager, Julian made the decision that the team will spend the summer of 2018 practicing manufacturing to gain technical skills once the design phase for the competition began. Once the Fall semester began, the team started to focus heavily on recruiting new members. As Julian put it, "we didn't have many returning members because the year before we did not compete, so that created a general waning of interest". After this, the team focused on training members to bring everyone up to speed on manufacturing practices, report and proposal writing, and design knowledge. In the next few months, the 2018-2019 team was able to design the competition's aircraft (more technical information about the aircraft may be found in Section V) that was capable of carrying attack stores on the wing, lift off of a ramp, spin a radome, and remotely convert the wings from a storage position to flight position. The aircraft was able to be flown in test flights, but was not cleared to compete in the competition. This was due to the rotating wing system used to change configurations having structural issues and was deemed unsafe at competition time. Even though the team was unable to compete, Xiaofeng Liu, the Faculty Advisor, reminded Julian of the true spirit of the competition. Julian's recollection of the event is as follows:

> "I'll tell you the same thing [Xiaofeng] Liu told me when we couldn't compete because obviously, as a Project Manager, I was very bummed. Liu is a teacher. He's always been about education for a long time. So, he sat me aside and told me that, 'You want to compete, you want to do well. Sometimes it may not happen, but what's most important is that you learn. This is
>
> get into the hobby that is RC Aircraft making and racing, and 2) to give them the opportunity to utilize concepts they learned in class.' At the time, Before Liu had mentioned that, I had considered [the 2019 competition] a failure. And it wasn't until he gave me that perspective and I had spoken to the other members how confident they were in what they learned. Looking from the beginning (of the 2018-2019 term) to now, there has been a lot of growth. That definitely offered a whole new light on it."

Figure 20: Members from the 2018-2019 SDSU DBF Team preparing a fiberglass layup for the 2019 competition plane's wing.

This would prove to greatly improve the morale of Julian, and the team as a whole. In addition, this perspective was able to reinforce SDSU DBF's values of giving students the opportunity to learn and grow for years to come.

The 2019-2020 year started just as any year had, with Christopher Jaquilmac as the new Project Manager. The team had designed and flew their first prototype, known as *Aurora*. Some significant changes were made to the ruleset, such as more restrictions on Lithium Polymer batteries, however the team progressed as usual.

Figure 21: Photograph of the 2019-2020 SDSU DBF Team preparing for their first test flight.

However, in the Winter of 2019 a new virus that would later be known as COVID-19 had been spreading rapidly, with its eventual arrival to the US in 2020. On March 10, 2020, AIAA made the difficult decision to cancel the 2020 DBF competition due to the COVID-19 virus spreading across the United States, creating a Pandemic[5]. Then, on March 12th, San Diego County also introduced a Stay-at-Home Order[6], restricting the gathering of people to only essential personnel. This meant that the team at SDSU DBF was unable to complete *Aurora* and begin adapting to an online curriculum. For the 2020 competition, AIAA announced that the scores for that year will be based on the design reports from each school with an optional video submission, placing SDSU DBF at 53rd out of 101.

In April 2020, Daniel O'Haire was voted to serve as the Project Manager for the 2020-2021 school year, leading what would turn out to be an exclusively virtual team for the majority of the year. The team would turn to the online communication software *Discord* to hold meetings and discuss the design for the next competition's plane. Hoping

for an eventual return to the classroom to manufacture *Sherlock*, the 2021 competition plane, the team continued at full effort to design an aircraft capable of completing the requirements for the competition. Due to COVID-19, members were not able to test physical prototypes or systems, so engineering software such as SolidWorks, Femap, and OpenVSP was relied on to support the design process. This process continued until after the report scores were released. AIAA announced that the competition would be held virtually, and Students had until April 18, 2021, to submit a video containing a thorough pre-flight examination and a demonstration flight of the school's aircraft.

Figure 22: Group Photo of the 2020-2021 Officers from SDSU DBF. From left to right, standing: Zachary Cohn, Sara Brandt, Andy Hernandez, Brendan Lameiro, Roberto Marquez, Jeremy Johnson; holding plane: Daniel O'Haire.

The team immediately began looking into options to safely be allowed on campus to manufacture the plane. SDSU DBF's advisor, Professor Xiaofeng Liu, recommended that the team submit a proposal to the University and the College of Engineering to conduct in-person airplane manufacturing activity. SDSU DBF began constructing a detailed proposal, describing how the team will manufacture *Sherlock* safely and within social distancing guidelines advised by the County of San Diego and San Diego State University. The University and the College of Engineering eventually approved the proposal, and the team was able to begin manufacturing the plane one week before the video submission deadline. The team began rapidly constructing the plane, being in the DBF Workshop until as late as 1:00 AM plenty of nights. At last, the night before the planned flight day for the plane, *Sherlock* had completed manufacturing and was ready to fly. Members of the team convened at the flying field on April 17, 2021, to conduct and record the flight, and after a few test runs, *Sherlock* was in the air and performing as planned. After experiencing technical difficulties (due to video file size) in regard to submitting the competition video on the AIAA website, the team eventually was granted access to complete the submission of the video entry and had finished the competition. Later, when the final results were presented by AIAA on May 14, 2021, it was announced that SDSU DBF placed 21st place in the 2021 competition, ranking them as the highest-scoring team in California and within the top 25 percent of all schools.

After the competition, Jeremy Johnson was elected to serve as the project manager for the 2021-2022 school year as regulations for COVID-19 begin lifting in Southern California. This brings SDSU DBF to its current status, where the newly elected team has returned to in-person activities at San Diego State University, and are designing an aircraft to excel in the 2022 Design/Build/Fly competition and many years to come. More details about the team's plan and vision for the future may be found in Section VIII.

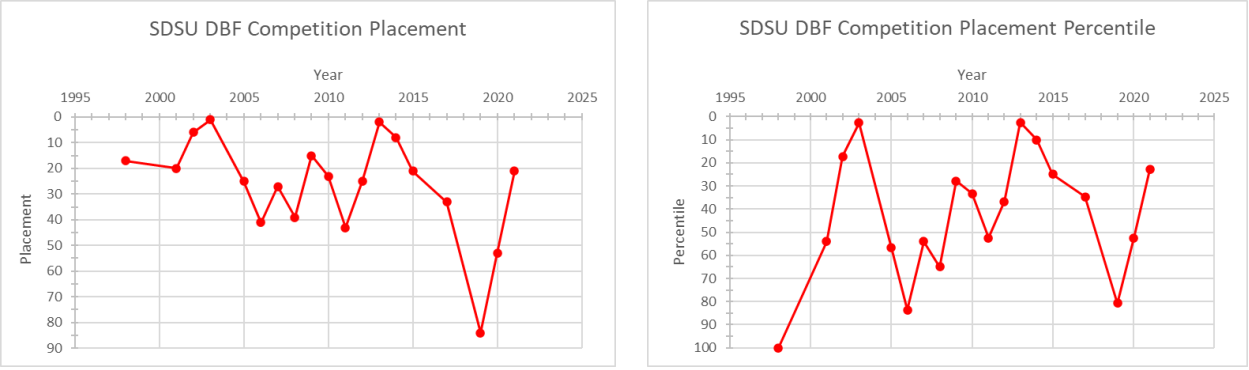
V. Achievements and Impact at SDSU

Throughout the history of Design/Build/Fly at SDSU, the various years' teams have had the opportunity to attain awards and recognition due to placement in competition scoring, quality of aircraft built, and presence of the team at SDSU. Since competing in the 1998 Design/Build/Fly competition, SDSU DBF has earned first place once, second place once, and has placed within the top 25th percentile 6 times[7]. Figure 23(a) represents the score that SDSU DBF earned each year. However, the overall score does not account for the overall number of teams competing each year, which has grown from eleven schools in 1997 to 101 schools in 2020. Figure 23(b) takes the competition size into account by portraying SDSU DBF's ranking as a percentile of all placements each respective year.

The most recent placement achieved by SDSU DBF was 21st place out of 92 schools in the 2021 competition, fitting the team well within the top 25 percent. This score also placed the team as the best ranking school in California for that year, with the closest being the University of Southern California at 26th place.

At San Diego State University, SDSU DBF is known as one of the biggest engineering clubs in the entirety of the school. SDSU DBF is currently part of the SDSU College of Engineering's "Big Six", shared with SDSU Rocket Project, Aztec Racing, Aztec Electric Racing, Aztec Baja, and SDSU Mechatronics. In the department of Aerospace Engineering itself, SDSU DBF has become well respected and known as the go-to club for aircraft design. Due to this

status at SDSU, SDSU DBF has the opportunity to impact the school's reputation with the team's success, adding more reasons for members to strive to succeed in the Design/Build/Fly Competition. Additionally, on the SDSU Aerospace Engineering Department's website, SDSU DBF is listed as one of the most influential student organizations in the department, and regards SDSU DBF as enhancing the education of San Diego State University students through participation.



(a) (b)

Figure 23: Graphical representations of SDSU DBF's placement each year of competition. (a) SDSU DBF placement each year in terms of overall placement, and (b) SDSU DBF placement each year as a percentile of all teams that competed each respective year.

SDSU DBF is well known among SDSU Professors and students as a great microcosm of the aircraft design process. One such example can be seen in the mini "Design/Build/Fly Contest" held in SDSU's introductory aerospace engineering class: *AE-123: The Aerospace Engineer*. Previously taught by Professor George "Captain" Faulkner and currently taught by Doctor Gary Fogel, *AE-123* strives to teach incoming Aerospace Engineering students an overview of what they will learn throughout their time at SDSU and to excite and welcome them into the field of aerospace industry. Every semester, the class has a mini-Design/Build/Fly competition where randomly assigned student teams in the class complete to make the best aircraft from two categories: rubber band propulsion and radio-controlled propulsion. SDSU DBF offers the teams competing in this school competition insight on aircraft design, fabrication tips, and allows the teams to use SDSU DBF's laser balsa cutter and CNC foam hotwire cutter.

Overall, the achievements earned by SDSU DBF have garnered the team a respectable reputation at San Diego State University, making them one of the most well-known clubs at the school's Aerospace Engineering department. SDSU DBF is planning on continuing the current momentum of placement and place within the top 10 schools in the years to come. More details on the vision for the future of SDSU DBF may be found in Section VII.

VI. Aircraft

The 1998 Design/Build/Fly Competition

The 1998 Design/Build/Fly competition was held in Wichita, Kansas, during April of 1998[7]. The objective of this year's competition was to create a plane capable of carrying 7.5 pounds of steel for payload and segmented into no more than three pieces. Performance was judged on the maximum number of complete laps over the specified flight course completed within seven minutes. A small team of San Diego State University students, led by Victor Hugo, gave their attempt in AIAA's second Design/Build/Fly competition. According to Richard Gunderson, a member of this team, the team designed a canard aircraft to compete. Unfortunately, The team was not able to understand the center of gravity needed for this configuration. Due to this, the team was unable to compete and received 17th place out of 17 teams, but marked the first time that San Diego State University was on the Design/Build/Fly leaderboard.

The 2001 Design/Build/Fly Competition

For the 2001 Design/Build/Fly competition in Ridgely, Maryland, the objective was to carry as much steel as an aircraft can hold for the first flight, and a maximum amount of tennis balls for the second flight[7]. The final scoring would be based on the maximum amount of cargo capable of being held, multiplied by the team's design report score, divided by the team's Rated Aircraft Cost. SDSU DBF designed and built *Full Monty* to compete, which was configured with a cylindrical fuselage, conventional tail section, and rectangular, foam wings. The landing gear was in a taildragger configuration. Greg Marien and Chad Berman both referred to this plane as *The Ugliest Plane in the World*, implying that it was not designed to win any aesthetic points. *Full Monty* and the 2001 SDSU DBF Team earned 20th place out of 37 teams, laying the groundwork for future years.

Figure 24: Photograph of the 2001 Competition Plane, *Full Monty*, at the 2003 Design/Build/Fly Competition in Ridgely, Maryland.

The 2002 Design/Build/Fly Competition

The 2002 Design/Build/Fly Competition was held in Wichita, Kansas, and revolved around engineering an aircraft for carrying softballs[7]. The softballs were not allowed to be stacked on top of one another however, so the plane needed to be wide for single-depth cargo. In addition, rapid loading and unloading was necessary for success. SDSU DBF's competition aircraft for this year, dubbed *Monty's Revenge*, was able to carry 24 softballs and featured a conventional tail and mid-wing configuration. Balsa wood and carbon fiber were primarily used for manufacturing the plane, along with Monokote for a smooth coating. *Monty's Revenge* earned the sixth best flight score, and after the report score and rated aircraft cost are factored, SDSU DBF earned 6th place in the 2002 competition out of 35 teams.

Figure 25: Photograph of the 2002 competition plane, *Monty's Revenge*, being displayed at the 2002 Design/Build/Fly Competition in Wichita, Kansas.

The 2003 Design/Build/Fly Competition

SDSU DBF was able to engineer an aircraft capable of achieving first place in the 2003 Design/Build/Fly competition out of 38 teams[7]. Designed to carry a 12-inch by 6-inch by 6-inch box and cylindrical payload separately, *The Spirit of Monty* utilized similar yet upgraded manufacturing techniques from the year prior, primarily featuring composite materials, balsa wood, and exterior coating. The wings are mounted on the top of the ellipsoid fuselage and are interlocked in order to balance structural integrity and ease of removal and cargo access. Attached to a boom, the aircraft featured a T-tail configuration for advanced control out of the region of turbulent wake caused by the propeller. Another parameter of this year was that the aircraft was required to fit inside of a box two feet wide, four feet long, and one foot high. *The Spirit of Monty* succeeded in this by being retractable to fulfill a much smaller size when in ground configuration. The front landing gear was foldable, the wings were removable, the main landing gear was removable, and the tail boom was retractable.

Figure 26: Photograph of the 2003 Competition Plane, *the Spirit of Monty*, at the 2003 Design/Build/Fly Competition in Ridgely, Maryland.

The 2005 Design/Build/Fly Competition

The next competition that SDSU DBF Received a score in was the 2005 Design/Build/Fly competition, held in St. Inigoes, Maryland[7]. For this year, the aircraft must fit within a 2-foot by 4-foot by 1-foot box. For the "Sensor Reposition" mission, a sensor will be taxied to the drop-off zone and removed from the aircraft after each lap, along with a later resupply mission. The final score was the flight score, multiplied by the design report score, divided by the aircraft's Rated Aircraft Cost. SDSU DBF developed Monty's Pride, which earned a report score of 84.25 and a Rated Aircraft Cost of 9.87, but was unable to compete in the competition, thus no flight scores. Due to this, *Monty's Pride* earned 25th place out of 44 competing teams.

The 2006 Design/Build/Fly Competition

The main objectives of the 2006 Design/Build/Fly Competition was to fit within a 2-foot by 4-foot by 1-foot box, be capable of carrying the following for the first mission: 48 tennis balls, two 2-liter soda bottles full of water, and one 4-inch by 1-inch by 24-inch wood block and was scored by the maximum number of laps in 10 minutes, divided by the loading time for the cargo[7]. Next, the aircraft had to hold 96 tennis balls and was scored by completion and Rated Aircraft Cost. The final score was the flight score, multiplied by the design report score, divided by the aircraft's Rated Aircraft Cost. SDSU DBF's aircraft, *Monty Python*, earned a report score of 79.05 and a 100 Rated Aircraft Cost, but was unable to be at the competition. Due to this, SDSU DBF earned 41st place.

The 2007 Design/Build/Fly Competition

The 2007 Design/Build/Fly Competition, held in Tucson, Arizona, required student teams to design an aircraft capable of fitting within a 2-feet by 4-feet by 1.5-feet box, and capable of holding an air sampler system featuring an "L" shaped tube, and a camera ball system[7]. The final score was the flight score, multiplied by the design report score, divided by the aircraft's Rated Aircraft Cost. SDSU DBF created *The Spirit of Monty II*, which was the first SDSU DBF aircraft that featured a "pusher" Propulsion system. In addition to that, the aircraft had a large, vertically-biased fuselage for holding the desired cargo, was on a tricycle landing gear configuration, rectangular wings, and a T-tail tail section. The team was able to travel to Arizona to compete and even passed the technical inspection and ground mission, but suffered from a test crash before the flight missions, making them unable to compete. At the end, SDSU DBF earned 28th place out of 50 competing teams in the 2007 Design/Build/Fly competition.

Figure 27: Photograph of the 2007 competition plane, *the Spirit of Monty II*, at a test flight in Tucson, Arizona, before the flight missions.

The 2008 Design/Build/Fly Competition

The 2008 Design/Build/Fly Competition, held in Wichita, Kansas, centered around the theme of designing a "Reconfigurable Short Field Transport" aircraft[7]. For the first mission, the aircraft was required to fly a maximum number of laps with the lightest battery possible for cargo. For the second mission, the plane must carry a randomly-selected cargo, which may be one of the following: 14 passengers, 4 cargo pallets, 10 passengers and 1 cargo pallet, 7 passengers and 2 cargo pallets, or 3 passengers and 3 cargo pallets. The final score was the flight score, multiplied by the design report score, divided by the aircraft's Rated Aircraft Cost. SDSU DBF's aircraft, *The Aztec,* centered around a stable aircraft with a large, square fuselage to handle any cargo assortment it was assigned with minimal risk. SDSU DBF was unable to compete, but earned 39th place out of 60 competing teams.

Figure 28: Photograph of the 2008 competition plane, *the Aztec,* at a test flight in San Diego, California.

The 2009 Design/Build/Fly Competition

The theme of the 2009 Design/Build/Fly Competition, held in Tucson, Arizona, was an "Unmanned Surveillance/Attack Aircraft". The aircraft was required to fit in a 2-foot by 2-foot by 4-foot box, store a 4-liter fuel tank full of water, and carry and release model rockets[7]. The Rated Aircraft Cost was embedded into the Pre-mission assembly mission instead of part of the final score, so the final score was only based on the report score multiplied by the flight score. Being the SDSU's first aircraft to be able to compete in competition since 2003, 6 years prior, the *B.A.M.* was built to prioritize a low-profile aircraft to externally carry the desired cargo. SDSU DBF was able to achieve a report score of 70.5, a Rated Aircraft Cost of 30.35 (8th best), Mission 1 score of 8.5, Mission 2 score of 0, and Mission 3 score of 0. The *B.A.M.* was able to earn 15th place out of 54 teams, placing SDSU DBF in the top 30 percent for the first time in six years.

Figure 29: Photograph of the 2009 competition plane, *B.A.M.,* at a test flight in San Diego, California, before heading to the competition in Tucson, Arizona.

The 2010 Design/Build/Fly Competition

The theme of the 2010 Design/Build/Fly competition was a "Baseball Team Plane" which required university teams to design an aircraft capable of carrying baseball bats and softballs[7]. The final score of the competition was the sum of the flight scores, multiplied by the design report's score. SDSU DBF's aircraft, *Monty's LN-7*, focused on having a large, box-shaped fuselage to store a maximum amount of softballs, and to store the baseball bats externally. *Monty's LN-7* had a top speed of 95 miles per hour, was able to take off in 83 feet, and was able to carry 10 softballs and 5 baseball bats, respectively. Despite incorrectly configuring the avionics system in the 3rd mission, SDSU DBF was still able to achieve 23rd place out of 69 competing teams in the 2010 Design/Build/Fly competition.

Figure 30: Photograph of the 2010 competition plane, *Monty's LN-7,* in the Baseball Bat Holding Configuration, at a test flight in San Diego, California.

The 2011 Design/Build/Fly Competition

The theme of the 2011 Design/Build/Fly competition, held in Tucson, Arizona, was a "Soldier Portable UAV" where the battery pack may weigh no more than 0.75 pounds, the plane must fit in a commercially purchased suitcase not to exceed 45 linear inches, complete a maximum number of laps in 4 minutes, carry as heavy of a steel piece of payload as possible, and carry a maximum amount of golf balls[7]. SDSU DBF's aircraft, *Monty's Bayfinder,* weighed in at 2.19 pounds utilized a flying wing design and a pusher propulsions system, with a "belly lander" landing gear; meaning there was no landing gear and the aircraft landed on its belly. *Monty's Bayfinder* was capable of flying at 53.1 miles per hour, carrying a 6-pound steel bar, and carrying 38 golf balls for missions 1, 2, and 3, respectively. The aircraft was only able to compete in the first mission, but did travel to Arizona to compete. After this, SDSU DBF earned 43rd place out of 60 teams at the 2011 Design/Build/Fly competition.

Figure 31: Photograph of the 2011 competition plane, *Monty's Bayfinder,* being hand-launched at a test flight in San Diego, California.

The 2012 Design/Build/Fly Competition

The theme of the 2012 Design/Build/Fly competition, held in Wichita, Kansas, was a "Small Passenger Aircraft" competition[7]. Aircraft in this competition were required to complete a maximum number of laps in 4 minutes, carry eight simulated passengers while having the aircraft as light as possible, and climb to 100 meters altitude as fast as possible capable of releasing two liters of water. The final score was decided by the sum of the flight scores, multiplied by the report score, divided by the square root of the aircraft's Rated Aircraft Cost. SDSU DBF designed *Mini Monty* to compete in the 2012 competition, which was a small aircraft with a thin, rectangular fuselage, a tapered balsa set of wings, a conventional balsa tail section, a tractor propulsions system, and a taildragger landing gear. *Mini Monty* was able to receive a 1.83 in the first mission, but failed to complete the other two. Despite this, SDSU DBF was able to receive a 3.38 RAC and a 73 report score, ultimately earning the team 25th place out of 68 teams.

Figure 32: Photograph of the 2012 competition plane, *Mini Monty*, on its maiden flight in San Diego, California.

The 2013 Design/Build/Fly Competition

The 2013 Design/Build/Fly Competition was held in Tucson, Arizona, and the objective was to create a "Joint Strike Fighter"[7]. The planes were required to hold attack stores simulating missiles in fighter jets, with a great scoring emphasis on the plane's speed and cargo holding capabilities. The first mission served as a Short Take-off demonstration as the plane needed to take off under the maximum runway that the judges decided on for competition day. Teams had four minutes to complete as many laps as possible, and the maximum number of laps flown contributed to the score for mission 1. The second mission simulated a Stealth Mission where the plane was to internally hold the attack stores described above and was scored on the maximum number of attack stores internally carried. The third mission was the Strike Mission, where the plane needed to hold attack stores both internally and externally, with each attack store's placement decided by the roll of dice. In addition to the flight scores, the 2013 competition also had a Rated Aircraft Cost (RAC) score which penalized planes that were heavier and had larger size factors. The sum of the mission scores was divided by the RAC Score, and the report score served as a multiplier.

Figure 33: Photograph of the 2013 competition plane in the SDSU DBF Workshop, photographed on September 17, 2021.

To create a plane capable of excelling with the design parameters mentioned above, SDSU DBF focused on creating a small, light plane capable of holding up to 5 internal attack stores in the fuselage, and 6 attack scores under the wing. In order to minimize the size factor of the plane, the team adopted a biplane configuration as shown in Figure 33, featuring both E210 and SD7032 airfoils for the top and bottom wings, respectively. The plane, when manufactured, had an empty weight of 56.58 ounces (about 3.53 pounds) which, in addition to the bi-plane configuration, minimized the magnitude that the RAC could bring down the team's score. This aircraft resulted in SDSU DBF receiving second place out of 81 competing teams in the 2013 Design/Build/Fly Competition.

The 2014 Design/Build/Fly Competition

The 2014 Design Build Fly competition was unique in which the plane had to simulate a backcountry rough field bush plane[7]. The Ground Mission was a taxi run in which the aircraft had to navigate through a rough terrain environment which was simulated using a Palruf roofing panel. If the aircraft were to receive any damage, depart to the side of the 8' course, or become airborne at any given moment, the attempt would be disqualified. Mission 1 was a speed focused mission, in which the unloaded aircraft had to complete as many laps as possible in the 4-minute flight window, in which the score was 2 times the ratio of number of laps flown versus the maximum number of laps flown. Mission 2 was a maximum payload mission, where the aircraft had to carry as many possible 6" x 6" x 6" wooden cubes, each weighing 1 lb. The aircraft had to complete 3 laps and the score received was 4 times the ratio of cargo flown versus maximum cargo flown. Mission 3 was an emergency medical mission which had the aircraft carry 2 sets of mock passengers, an attendant and a patient. The total weight added to 4 lbs. and the aircraft was tasked to finish 3 laps as fast as possible. The score received was 6 times the ratio of the fastest time flown versus the time flown.

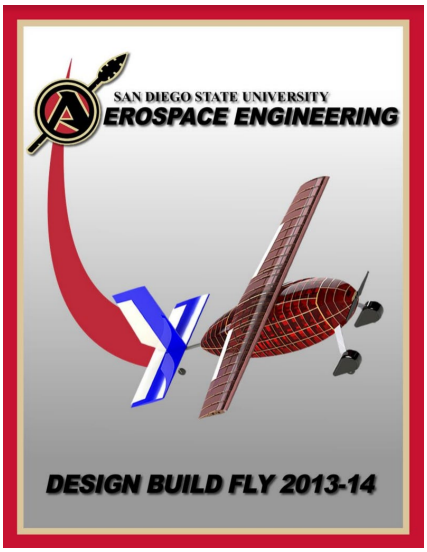


Figure 34: Cover page of the SDSU DBF's Design Report for the 2013-2014 Kansas competition, showing the final design of the 2014 aircraft.

The 2015 Design/Build/Fly Competition

One UAV was required for the 2015 Design Build Fly Tucson competition[7]. The objective of the UAV was to maintain high cruise speeds in order to complete as many laps as fast as possible while carrying heavy payload, as well as to individually deploy 12" plastic balls for every lap flown. The UAV was a square fuselage design with a dihedral balsa wing designed to carry two of the plastic balls on the tail section with space inside the fuselage for the payload.

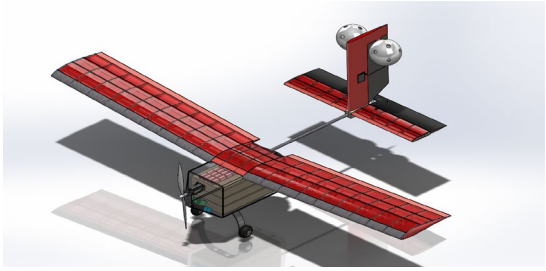


Figure 35: Rendering of the SDSU DBF "Reconnaissance" UAV for the 2014-2015 Tucson Competition

The 2016 Design/Build/Fly Competition

Two Unmanned Aerial Vehicles were to be built for the 2016 Design Build Fly competition, which was held in Wichita. The first of which was the *Production Aircraft (PA)*, the second was the *Manufacturing Support Aircraft (MSA)*[7]. The PA was designed to carry a payload, a 32oz. bottle of Gatorade. The MSA however, was designed to carry a disassembled PA. This was meant to mimic real world instances of sub-assemblies of aircraft being carried to a centralized location, to then build an aircraft capable of completing unique missions, i.e. carrying a payload. The scoring parameter of that year had a rule which favored a PA with less sub-assemblies, as the score multiplier would decrease if the more sub-assemblies were involved. Mission 1 was a simple demonstration of flight in which the MPA had to complete 3 laps in under 5 minutes to receive the points. Mission 2 was the MPA delivery flight. The MPA was meant to complete repeated laps in which the aircraft carried and deployed different components of the PA until they had delivered all the sub-assemblies or the 10-minute flight window expired. A full score was only achieved if all sub-assemblies were delivered. Mission 3 was to be flown by the PA, where the aircraft had to complete 3 laps in under 5 minutes while carrying the payload.

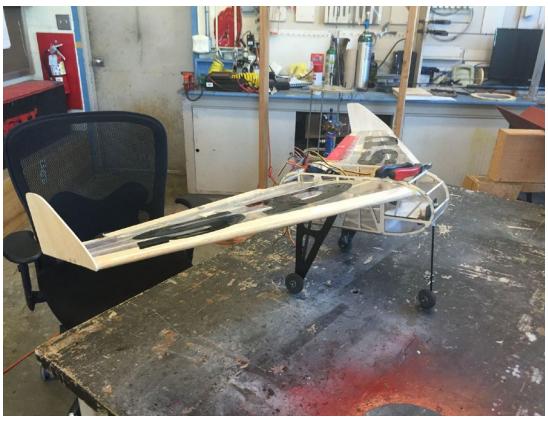


Figure 36: The MSA fully assembled in the SDSU Design Build Fly Blockhouse.

The 2017 Design/Build/Fly Competition

A tube-stowed Unmanned Aerial Vehicle was designed for the 2017 Design Build Fly Competition in Tucson, Arizona[7]. This was designed to portray tube-stowed aircraft in the Aerospace Industry, where a plane may be stowed to be extremely compact and be launched from anywhere. Because of this, the plane was required to be able to be stowed inside of a cylindrical tube, and then be launched into the air by hand. The aircraft would then be required to withstand drop tests inside of the tube to demonstrate durability, and include a self-locking mechanism for the wings so once taken out of the tube, the plane will immediately be prepared for flight. The plane itself was required to carry hockey pucks as a payload, so balancing a maximum amount of hockey pucks and having a small plane was required. The first mission of the competition was simply a demonstration flight, which was scored upon whether the team was able to complete 3 laps in 5 minutes or not. Mission 2 served as a speed flight, where the plane was required to hold three hockey pucks and complete three laps as fast as possible. Mission 3 was an endurance mission, where the plane needed to hold as many hockey pucks as possible, and complete as many laps as possible within 5 minutes. The SDSU DBF 2017 team was able to engineer a plane designed to complete 3 laps in mission 2 within 124 seconds and to complete seven laps while holding three hockey pucks for mission 3.

Figure 37: Photograph of the 2017 competition plane being hand-launched at the 2017 Design/Build/Fly competition in Tucson, Arizona.

The 2019 Design/Build/Fly Competition

The 2019 Design/Build/Fly competition required the planes competing to lift off of a ramp, change wing configuration from stowed to flight, rotate an externally attached radome, and drop attack stores upon command[7]. SDSU DBF decided to maximize wing area in order to hold the maximum number of attack stores possible under the wings. The wings were constructed using a foam core and fiberglass layup to have a much more structurally sound wing capable of carrying the attack stores, and the fuselage was created out of foam wrapped in fiberglass in order to minimize the weight of the aircraft. To succeed in the wing configuration requirement, the team designed a wing that was able to rotate from a configuration collinear to the fuselage, to one perpendicular. For the attack stores, release clamps were used to let go of them when a switch was flipped on the pilot's controller. The radome was capable of rotating around its axis due to a continuous rotation servo. However, the main issue regarding that year's plane was that there were issues with respect to having the wing be able to simultaneously rotate and be structurally safe on the wing. At the time of the competition, these issues deemed the plane unable to compete. But after the competition, the team worked out the problems and had a fully functioning aircraft capable of doing all requirements as set in the competition.

Figure 38: Photograph of the 2019 competition plane at the 2019 Design/Build/Fly competition in Tucson, Arizona.

The 2020 Design/Build/Fly Competition

Aurora, the competition plane for the 2020 Design/Build/Fly competition, was designed to deploy and tow a banner mechanism in flight and carry plastic passengers, plus luggage for each passenger. The competition involved a Ground Mission and empty test flight for Mission 1 as traditionally done[7]. Mission 2 required the plane to carry both plastic passengers and luggage for each passenger and fly 3 laps in 5 minutes. In Mission 3, The plane was to take off in 20

feet, deploy a banner mechanism after the first turn, pass the finish line, and detach the banner within 10 minutes. It must be noted that due to COVID-19 beginning during the time when the final aircraft was being manufactured, Aurora was not able to be completed. However, a prototype model was able to be manufactured and was able to tow the cloth banner. This aircraft was primarily constructed using carbon fiber wet layups for the fuselage, wings, and tail. This structural configuration proved optimal for testing scenarios due to its strength and impact resistance, but proved to be heavy, which was to be accounted for in the designs of the final model. Aurora was designed to tow a banner with dimensions 55 inches by 11 inches, which had fishing weights attached to the bottom of the banner to improve flight stability. As for the passengers, the final version of Aurora was to hold 16 passengers and 16 pieces of luggage. The final version of Aurora was to weigh 8.36 pounds, 14.66 pounds, and 8.76 pounds for missions 1, 2, and 3, respectively.

Figure 39: Photograph of the 2020 Competition Plane Prototype, *Aurora*, in the SDSU DBF Workshop.

The 2021 Design/Build/Fly Competition

The most recent plane created by SDSU DBF was *Sherlock*, the aircraft for the 2021 DBF competition. This plane, as described in the 2021 DBF competition rules, was required to deploy and recover a Towed Sensor and carry a maximum amount of cargo[8]. The plane needed to outperform the competition in four missions: a Ground Mission to demonstrate operations and dimensions of the plane, Mission 1 which required the plane without cargo to complete 3 laps within 5 minutes, Mission 2 which required the plane to complete 3 laps in 5 minutes, but with a maximum amount of cargo and the sensor mechanism installed, and Mission 3 which required the Sensor to be deployed out of the plane and eventually recovered back. *Sherlock* was designed to deploy and recover a sensor that was 6 inches long with a diameter of one inch, and be able to hold 20 pieces of cargo. The sensor mechanism, which was the highlight of the year's competition, had an embedded power source and microcontroller to power 3 LEDs in a distinct pattern. A pair of wires served to both tow the sensor from the plane and send signals to the sensor when to start and stop the LED flashing pattern. Inside the plane, a continuous rotation servo was used to spin a spool of the tow wire to deploy and recover the sensor. As for the plane itself, *Sherlock* was equipped with an MH-144 airfoil at a 5-degree dihedral and a 4.8-degree angle of incidence. As for the dimensions, *Sherlock* had a 60-inch wingspan, and a fuselage measured 60-inches from front to back. The mission weight configurations were 8.65 pounds, 15.44 pounds, and 10.46 pounds for missions 1, 2, and 3, respectively.

Figure 40: Aerial photograph of the 2021 competition plane, *Sherlock*, towing the deployable sensor in San Diego, California.

VII. Where The Alumni Are Today

For more than 20 years, SDSU DBF has given decades of students the opportunity to grow from students to experts at the cutting edge of the Aerospace Industry. Most SDSU DBF alumni find themselves in successful occupations, ranging from engineers at large Aerospace companies, test pilots, and more, even puncturing into the medical industry.

Throughout the decades worth of interviews with former SDSU DBF Project Managers, one common theme resonated with them all: SDSU DBF was the primary experience that prepared themselves for success in their respective practices. One such example are the words of Jeromey Suko, the Project Manager for the 2012-2013 SDSU

DBF team, currently working as an engineering manager at Raytheon Technologies. Suko explained how one highlight of SDSU DBF is that it allows the members to become acquainted with the aerospace industry and create valuable connections that will assist in establishing them.

> "The hard work and networking at DBF just led to a ton of opportunities and basically jump-started my career. Basically, you have the opportunity to meet engineers all around the industry like Northrop (Grumman) and everybody else that you get to interact with. The networking and connections are probably some of the greatest parts of SDSU DBF due to being able to meet people in the industry really early on and having those people know you and what you've accomplished."

In a conversation with Greg Marien, the Project Manager of SDSU DBF during the 2002 and 2003 competition years, the latter of which SDSU won first place and mentor to every year since as a representative of Northrop Grumman, he explained how his hard-work in SDSU DBF helped him be prepared for a life as an engineer and get his foot in the door in Northrop Grumman. For almost twenty years, Marien has had the opportunity to work in many technical positions, and eventually rise to being the manager of his own team. As he puts it, simply being in SDSU DBF is not an instant gateway to a job, but rather gives motivated students the opportunity to have their dedication and accomplishments be noticed by influential members of some of the biggest aerospace companies. As he puts it,

> "Certainly, DBF back in that day got me in the room at Northrop Grumman. It essentially got me an interview when we presented our designs, which led to an internship, which led to a job the moment I graduated. But, it wasn't just because of the relationship, but the activity that was going on. [Northrop Grumman] saw what I was doing, identified me, and said 'hire this guy right away'. Not just networking is important, which is what a lot of people try to do. What's important is networking where they can see you as an asset to their company… There are, of course, recruiters out there, searching for someone with good grades, but they also look for things like [engagement in project activities like SDSU DBF]. What you are doing (in SDSU DBF): designing, working with a team, solving tough problems, even including butting heads and how you deal with your relationships and that diversity of opinion is just as important as the outcome. My career has mainly been in technical design roles. I did a lot of design and structures, mechanisms, electromechanical, servo actuators, aircraft configuration, conceptual design, preliminary design, production. I've done all of these things, but I've had an aptitude toward it because of DBF, because you already do everything you will do (in the aerospace industry) in DBF… Because you already have all of that, you walk into your job knowing how to do it."

Even though most of the contributing members of SDSU DBF's history have found themselves successful engineering careers in the aerospace industry, some have found themselves into other positions, such as military, computer programming positions, or even engineering for the medical industry. Matthew Hager-Tompkins, Project Manager for the 2011-2012 SDSU DBF team, explained how his leadership experience helped him through positions in the military and eventually the tech industry for healthcare applications.

> "When I left SDSU, I joined the Navy and became a submariner. Within the application of that, at some point you do an interview with the admiral in charge of all the nuclear reactors and you have to talk about leadership examples. I leaned heavily on my DBF and AIAA experiences during this time. I was a submariner for eight years, then in 2019 I moved up to Seattle to work at a tech consultant company where I'm currently working as a data integrity manager… where I'm responsible for quality assurance for assumed error for healthcare devices. Keeping your energy and enthusiasm up and putting a lot of effort into [opportunities like SDSU DBF] is the stuff that really helps you grow up and going to help you in interviews. [Members of SDSU FDBF] will look back fondly at their time participating and will have experience in random things that may come up one day, like work in carbon fiber… or experiences in forming Figures of Merits."

Through two decades worth of former Project Managers of SDSU DBF were interviewed that found themselves in various successful positions, they all resonated the tune that their experience and efforts in SDSU DBF not only helped them get connected with engineering companies around the United States and assisted them in striding through interviews, but it also gave them the tools needed to actually perform the engineering job that they had always desired to do. Very little would disagree with the assertion that the Design/Build/Fly competition serves as a microcosm of the aerospace industry, giving members the tools needed to live a successful life in their desired career, and that SDSU DBF's decades of history assisted generations of San Diego State University students reach their desired positions.

VIII. Looking Ahead

As of Fall 2021 at the time of this writing, restrictions at San Diego State University due to COVID-19 have been mostly alleviated, where students have been permitted back on campus. This means that the new SDSU DBF team has been able to return to the DBF Workshop, and begin making preparations for the 2022 Design/Build/Fly competition. A main focus of this year's team has been repairing DBF machinery, such as the CNC hotwire foam cutter and computers, due to a power surge frying all of SDSU DBF's computers some time during the pandemic. SDSU DBF is also in the process of manufacturing a prototype for the 2022 competition, which will revolve around impact-sensitive vaccine vials that are required to be ground deployed each lap. Due to the 2020 competition being cancelled and the 2021 competition being held virtually, no student currently in SDSU DBF has had the opportunity to travel to the Design/Build/Fly competition. The team is eager to finally be able to travel to Kansas for this competition, after waiting for the past two years.

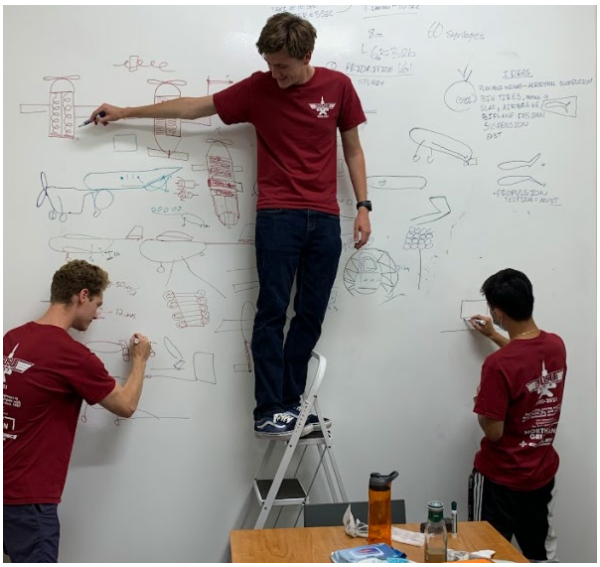


Figure 41: Photograph 2021-2022 SDSU DBF members in a late-night preliminary design session.

In order to build off of the momentum from the past few years, the team is striving to achieve an even better placement. However, to strive for the team to excel in the competition and offer members the hands-on opportunities, it is imperative to understand the history of SDSU DBF and how it got to where it is today. By connecting with SDSU DBF's roots and alumni, this year's team has been able to gain insight on the lessons learned in its 24-year history. Overall, Design/Build/Fly at San Diego State University has had a rich history of achievement and assisting students in gaining the experience to succeed in and progress the Aerospace Industry.

Figure 42: Photograph of the 2021-2022 SDSU DBF Team, photographed 8 October, 2021.

Acknowledgments

We would like to give our sincere thanks to all of the team members and advisors throughout the history of Design/Build/Fly at San Diego State University, such as Professors George Faulkner, Gary Fogel, Joseph Katz, Satchi Venkataraman, Allen Plotkin, Ping Lu, Nagy Nosseir, Gustaaf Jacobs, Luciano Demasi, Balbir Narang, Xiaofeng Liu and many more, for doing their part to bring the team to where it is today. The team would not have continued without your support and we would not have had this opportunity, if not for their dedication and effort to for SDSU DBF excel in the DBF competition.

To Daniel O'Haire, 2020-2021 SDSU DBF Project Manager, and Carlos Ortega, 2021-2022 SDSU DBF Outreach Coordinator, we extend this gratitude for your continued support in the research for this project.

Since 1997, generations of San Diego State University students put their hearts and souls into SDSU DBF, bringing it to where it is today. Every single year made a contribution, which deserves specific gratitude.

- *1997-1988 Team*: Thank you Victor Hugo, Richard Gunderson, & team for being the first group of SDSU students to compete in the Design/Build/Fly competition, and getting SDSU on the leaderboard.
- *2000-2001 Team*: Thank you Chad Berman, Greg Marien, Tim Lo, Andy Bechtel, and everyone else in the 2000-'01 team for establishing the SDSU DBF team that proved to impact over 20 years' worth of SDSU students.
- *2001-2002 Team*: Thank you for continuing the progress made from the previous year and further establishing SDSU DBF, and Professor George Faulkner for spearheading the Northrop Grumman Preliminary Design Review, which would prove to be an amazing professional experience for years of SDSU DBF teams.
- *2002-2003 Team*: Thank you all for the long nights in the blockhouse designing and building *The Spirit of Monty* and proving that SDSU DBF is a winning team. Additionally, thank you Greg Marien for your mentorship of countless years of SDSU DBF to this day.
- *2003-2004 Team*: Thank you for your work to keep SDSU DBF going after the graduation of many of the founding members, proving that SDSU DBF was here to stay.
- *2004-2005 Team*: Thank you to Don Myers & team for your dedication to get SDSU DBF back onto the competition stage.
- *2005-2006 Team*: Thank you Don Myers & team for persisting over two years to cement SDSU DBF as a team belonging at San Diego State University and the Design/Build/Fly competition.
- *2006-2007 Team*: Thank you for pushing to get SDSU DBF back to having a physical presence at the Design/Build/Fly competition.
- *2007-2008 Team*: Thank you for creating a competition-worthy aircraft and bringing along many mentors that have assisted SDSU DBF to this day.
- *2008-2009 Team*: Thank you Guinness Helfrick & team for your hard work in getting SDSU DBF competing once again in the Design/Build/Fly competition.
- *2009-2010 Team*: Thank you to Monique Fine & team for the devotion to creating an aircraft that made other schools remember to watch out for SDSU DBF.
- *2010-2011 Team*: Thank you to James Hroza & team for continuing the momentum of SDSU DBF's progress and setting the baseline of design report quality for future SDSU DBF teams to follow.
- *2011-2012 Team*: Thank you to Mathew Hager-Tompkins & team for introducing new manufacturing technologies to SDSU DBF, which proved to benefit future teams to this day.
- *2012-2013 Team*: Thank you to Jeromey Suko & team for all of those long nights, even the all nighters manufacturing from Jeromey's garage, to engineer the aircraft that would cement SDSU DBF as a winning team, across generations.
- *2013-2014 Team*: Thank you to Terry Ngo & team for keeping SDSU DBF's reputation as a top-performing team, placing us yet again within the top ten.
- *2014-2015 Team*: Thank you to Chris Long & team for your efforts to open the door to the Aerospace Industry for many of the SDSU students and all your advice moving forward with the project.
- *2015-2016 Team*: Thank you to Dorian Andersen & team for your work to make SDSU DBF an independent RSO at SDSU, introducing Dr. Liu to the team, and proving the resolve that this team has to create a winning plane, regardless of the obstacles.
- *2016-2017 Team*: Thank you to Nick Fritzler & team for your enthusiasm to create a spectacular aircraft, and for giving a record number of SDSU students to witness the Design/Build/Fly competition with their own eyes.

- *2017-2018 Team*: Thank you to Ben While & team for your work to move SDSU DBF to the EIS Building, and your efforts to teach SDSU students practices that they otherwise would not have been able to learn in the classroom, despite the challenges.
- *2018-2019 Team*: Thank you to Julian Johnson & team for having faith in your project until the end, and for your advice of the importance of learning for many future years of SDSU DBF to recognize.
- *2019-2020 Team*: Thank you to Chris Jaquilmac, Tony Luu, Tanner Andrzejewski, Prince Glick, James Felix, Jamie Blockey, Daniel O'Haire, & team for working to make an amazing plane, even if we weren't allowed to finish it, thanks to COVID. Also, thank you for providing a great experience of SDSU DBF to us writing this when we were freshmen, which motivated us to become even more engaged with the team and eventually become Project Manager and Co-Project Manager ourselves, and write this paper.
- *2020-2021 Team*: Thank you to Daniel O'Haire, Brendan Lameiro, Andy Hernandez, Sara Brandt, Zachary Cohn, Kendall Dizon, Niel Gillet & team for proving that the resolve and bond of SDSU DBF is stronger than any pandemic, and for adding another commendable placement on SDSU DBF's reputation.
- *2021-2022 Team*: Thank you to Elex Leary, Max Dommers, Henry Logsdon, Chandara Heng, Carlos Ortega, Thomas Hubbard, Gabriela Gonzalez-Ayala, & team for your continued support to get our team to the top of the scoreboard once again and for the development of the *Quetzalcoatl*. The best is yet to come!

A team such as SDSU DBF would not have lasted for the time that it has without the support of the faculty at the Department of Aerospace Engineering at SDSU, and such a competition is only possible because of the efforts from the DBF Organizing Committee at AIAA. Thanks to AIAA for creating an environment that nurtures future engineers and helps realize their goals, and for putting endless work every year to make every Design/Build/Fly competition the best that it can be. Additionally, thank you to AIAA for hosting the SciTech Forum, which has given us the opportunity to document and share the history of SDSU DBF.

Thank you to the many mentors that have helped SDSU DBF with flight advice and piloting through these years, such as Steve Neu, Steve Manganelli, Pedro Brantuas, and more. Your help has played an influential role in assisting many teams become winning teams.

Lastly, thank you to Dr. Xiaofeng Liu for your dedication to providing and teaching SDSU students to realize their fullest potential. Additionally, thank you for your unconditional support to SDSU DBF over the years, influencing many of the members who have had the opportunity to take part. Thank you as well for inspiring us to write this documented history, and we hope it will serve to benefit SDSU DBF teams for many years to come.

SDSU DBF is not just a team, rather a generational community where many students have learned and grown, and many more will for years to come. For this reason, we believe that it is important to document the history of this team and present the significance of SDSU DBF and the AIAA Design/Build/Fly competition as a whole.

References

[1]AIAA (2021). "About Design Build Fly." URL: https://www.aiaa.org/dbf [retrieved 17 May 2021].

[2]SDSU Design Build Fly (2020). "About Us." URL: https://www.aiaa.org/dbf [retrieved 17 May 2021].

[3]AIAA (2015). "2003 Results - Cessna/ONR Student Design/Build/Fly." URL: https://www.aiaa.org/docs/default-source/uploadedfiles/aiaadbf/previous-competitions/results/2003-results87e206507d1e4972b2d7d2302cfc05e2.pdf?sfvrsn=255cf581_0 [retrieved 30 May 2021].

[4]AIAA (2013). "2013 Design/Build Fly Competition Final Results." URL: https://www.aiaa.org/docs/default-source/uploadedfiles/aiaadbf/previous-competitions/results/2013-resultsfaf071b7bb6d4890b91ddfc3dcbace02.pdf?sfvrsn=7caa5c24_0 [retrieved 30 May 2021].

[5]AIAA (2020). "AIAA Design/Build/Fly (DBF) 2020: Event Cancellation," URL: https://staging-aiaa.rd.net/dbf/example-dbf-feature [retrieved 19 May 2021].

[6]Macchione, Nick and Wooten, Wilma J., "Order of the Health Officer" *Health and Human Services Agency*, County of San Diego published 12 Mar. 2020.

[7]AIAA (2021). "Previous Competitions." URL: https://www.aiaa.org/dbf [retrieved 19 May 2021].

[8]AIAA (2020). "2020-21 Design, Build, Fly Rules." URL: https://www.aiaa.org/docs/default-source/uploadedfiles/aiaadbf/dbf-rules-2021-final-v01.pdf?sfvrsn=f51d2f69_2 [retrieved 30 May 2021].