



Alexandria University
Faculty of Engineering
Mechanical Engineering Department



PEGASUS
Aerodesign



2019

Radio Controlled Aircraft

SAE Aerodesign Competition

Alexandria University, Faculty of Engineering

SAE Aero Design Competition 2019

Pegasus Aerodesign Team

Radio-Controlled Aircraft

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Summary

This proposal gives full demonstration for a Radio-Controlled Aircraft project and participation of Pegasus Aerodesign Team in "**SAE Aero Design Competition 2019**". This document intends to give full details required for funding the project and its expected expenses until the competition in March 2019. It includes introduction about the project and the competition, team's mission, team's management system, sophisticated plan for achieving a high-quality output and full budget analysis. Besides the innovative strategy made through designing using advanced tools and software that will be a great contribution in achieving the sustainable vision that qualifies the students to submit for Aero Design competitions annually.

Contents

1. Introduction	5
2. Mission	5
3. Objectives	5
4. RC aircraft project overview	6
5. SAE Aero Design Competition	7
6. Project timeline	8
1)Literature Review.....	8
2)Design Process	9
3)Fabrication Process	11
7. Sponsorship regulations	12
8. Budget and Cost Analysis	13
9. Pegasus Aerodesign history	14
10.Pegasus in Media.....	14

Introduction

Pegasus Aerodesign is a technical team based in faculty of Engineering - Alexandria University. It was founded in September 2015 under the supervision of Mechanical engineering academic staff. Its main vision to establish a solid base in the aeronautical engineering field in Alexandria University by participating in international and local competitions, assigning graduation projects to the members in their last academic year and by conducting research projects which enriches the students with more knowledge and experience in the field. Pegasus Aerodesign team consists of mechanical, electromechanical and production engineers from all academic years. The team's main project is designing and fabricating RC (Radio-controlled) aircraft with specific requirements which is the graduation project for the fourth academic year students.

In order to achieve Pegasus goals, the team participates every year in SAE Aerodesign Competition which is organized by SAE international organization. The SAE Aero Design competition is intended to provide undergraduate and graduate engineering students with a real-life engineering challenge. The competition has been designed to provide exposure to the kinds of situations that engineers face in their real-life work environment.

Mission

Develop a sustainable system that allows the team proceed in its objectives and participate in aero design competitions annually.

Objectives

- Initiate a solid base for scientific research in the aeronautics field through several studies on the designed plane.
- Achieving top ranking in the aero design competitions.
- Build high quality and functional Aircrafts that perform its required task effectively.
- Provide annual growth of students interested in the participation in Aeronautical competitions.
- Conduct many activities that help the students to get involved in the science of Aeronautical Engineering.
- Assure a sustainable system that provides an optimum structure through a feasible workflow.

RC aircraft project overview

This project was designed to compress a typical aircraft development program into one calendar year, taking students through the system engineering process of breaking down requirements. It will expose students to the nuances of conceptual design, manufacturing, system integration/test, and sell-off through demonstration. Moreover, the project was a simulation for real-life projects not only a technical project which creates more roles and responsibilities.

The objective of the project is based on the SAE Aero Design competition rules which aims to design an aircraft that can generate revenue by carrying as much payload as possible while observing the power available requirement which is limited to 1000 watt. The project is a simulation for the passenger's airplane as shown in figure (1), that can be designed to reduce power consumption by optimizing the weight of the airplane to increase the capacity for more payloads. Payload consists of passengers and their luggage which must be carried on each flight.

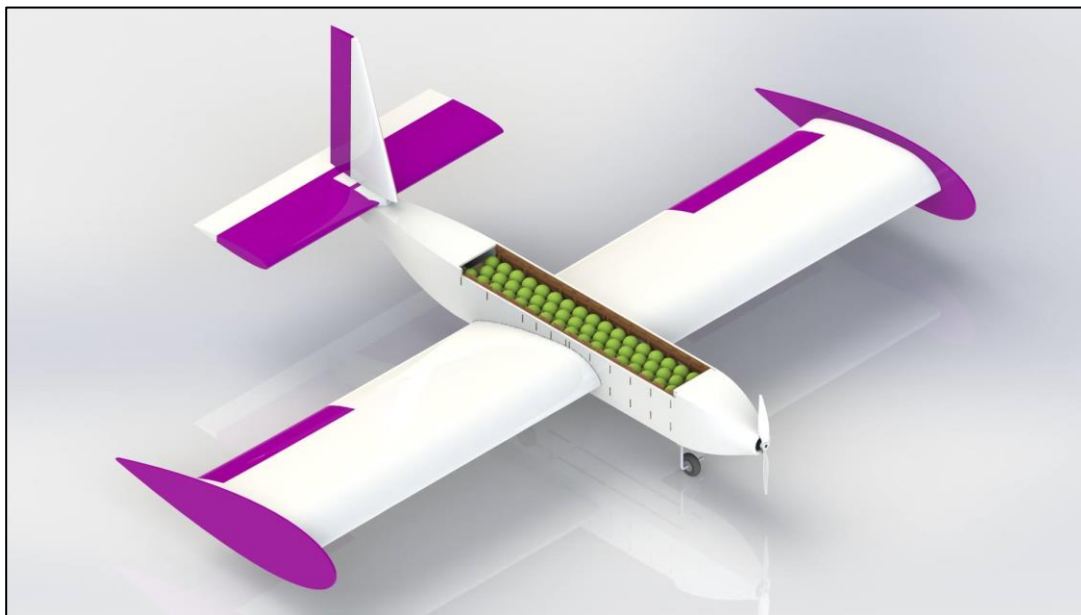


Figure 1. Simulation aircraft with passengers and payload

SAE Aero Design Competition

The SAE Aero Design competition is intended to provide undergraduate and graduate engineering students with a real-life engineering challenge. The competition has been designed to provide exposure to the kinds of situations that engineers face in their real-life work environment. First and foremost a design competition, students will find themselves performing trade studies and making compromises to arrive at a design solution that will optimally meet the mission requirements while still conforming to the configuration limitations. The importance of interpersonal communication skills is sometimes overlooked, yet both written and oral communication skills are vital in the engineering workplace. To help teams develop these skills, a high percentage of a team's score is devoted to the design report and the oral presentation required in the competition.



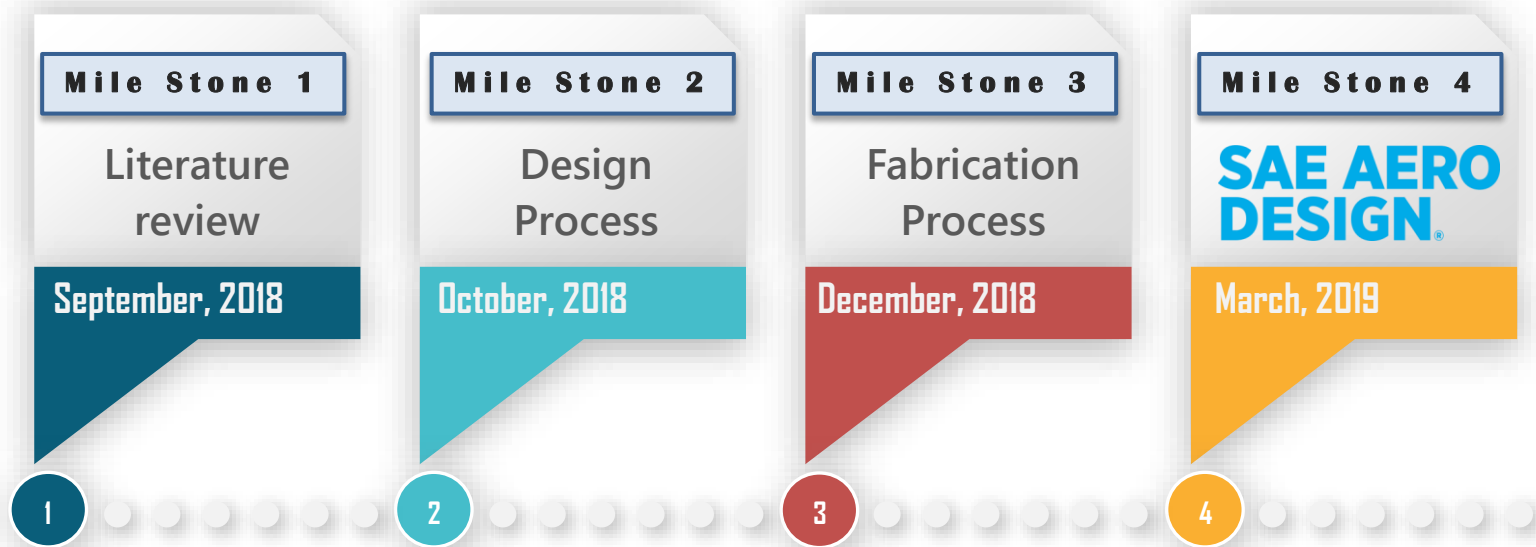
Competition's mission

Designing and fabricating a Radio-controlled Aircraft that can achieve the competition's mission; which is making a successful take off and have a 360-degree round on 200 feet, then making another several rounds by increasing the targeted payload that the aircraft can carry which is resembled as real payloads (Tennis balls as passengers and their luggage's).

Competition's Sponsors



Project timeline



1) Literature Review

The main purpose of the literature review is to go deeply in the details of designing and fabricating of the aircraft. It includes all the inputs and information that is helping us since the beginning, starting with the references, workshops and tutorials, taking into account the previous design reports and configurations.

Previous Designs

Pegasus 2016



Pegasus 2017



Pegasus 2018



2) Design Process

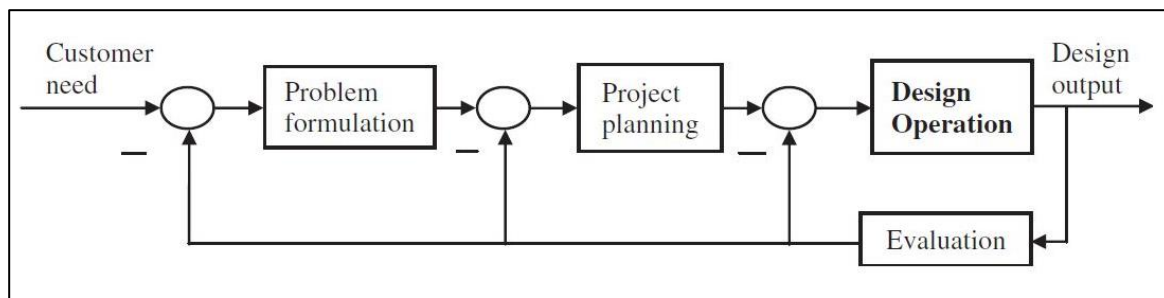


Figure 2. Design block diagram

Our engineering design process is operated as shown in figure 2, it represents the flow from the design requirements to design output including feedback based on evaluation. The evaluation not only influences the design operation but greatly affects the project planning. We also relies on the consultancy from experienced mentors from several layers (Professors, Supreme teaching staff in different fields, a former minister of petroleum and Post graduate students participated in pervious competition that helps the team to overcome the past obstacles).

Design Requirements:

Like basically any product, the aircraft design originates from a set of requirements that will function as a guide during the whole process. Therefore, the team established design requirements based on SAE aero Design competition rules:

- **Purpose of the model:** Radio controlled UAV with maximum possible lifting capacity.
- **Competition constrains:**
 1. **Power system:** Electric motor powered by a 6-cell lithium polymer battery, limited by 1000-watt power-limiter.
 2. **Maximum overall aircraft weight:** 55 pounds.
 3. **Field length:** 200 ft. Takeoff & 400 ft. landing
 4. **Material:** Fiber-Reinforced Plastics and lead are prohibited.
- **Stability and maneuverability:** high level of stability while maintaining adequate margin for maneuverability.
- **Transportation:** For ease in transportation, the aircraft must be dividable.
- **Scheduling:** 6 months for designing and fabricating.

Studying and evaluating those requirements, we have established a design wish-list as shown below to be satisfied during the design process:

1. Compact configuration.
2. Generate Maximum possible lift.
3. Minimize Drag (Required Thrust) as possible.
4. Maximize the available thrust within power constraints.
5. Highly stable, controllable aircraft (Promotes successful flight).
6. Accepted Takeoff & Landing performance.
7. Minimize empty aircraft's weight.
8. Satisfy the structural strength requirements.

This desired design was carefully considered in each design phase, upon which our design was an optimum from all aspects.

Team Structure

During the design phase, the team were divided into three subteams as shown in table, roles were distributed on the team members according to their technical experience:

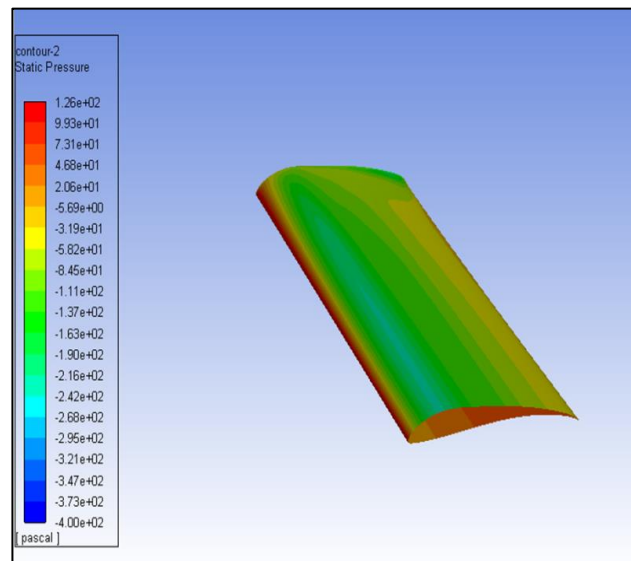
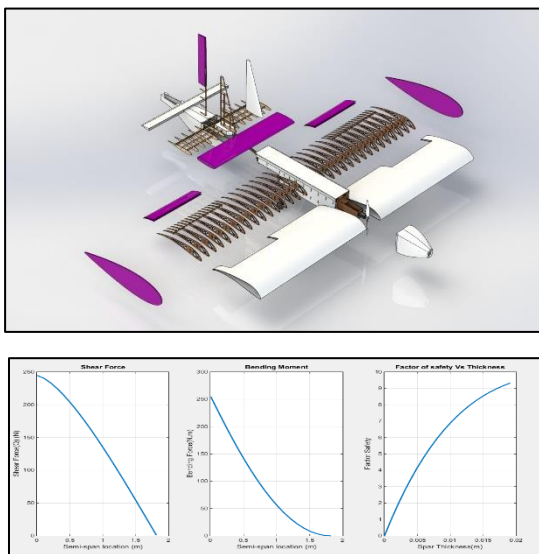
Aerodynamics	Flight Dynamics	Structure	Supporting team
Wing Design	Performance Analysis	Internal configuration	Fundraising
Tail Design	Control and stability	Material Selection	Marketing
Fuselage Design	Propulsion	Stress analysis	Procurement

High level of coordination, management and leadership in the team is developed through the previous three years to enhance the workflow between the members and finishing the tasks before the deadlines.

Design tools

Exerting the optimum efforts to implement a unique design by using advanced software

- 1- ANSYS for CFD analysis and FEM.
- 2- Xflr
- 3- Primavera for team management.
- 4- MATLAB for calculation and graphical analysis.
- 5- SolidWorks for 3D design.



3) Fabrication Process



Sponsorship regulations

Benefits granted for supporting Pegasus team in SAE Aero Design competition:

1. The sponsor is acknowledged as a Sponsor for the team online on the team's online media (Facebook page and further available).
2. The sponsor is acknowledged as a Sponsor for the team in any TV reportage.
3. Sponsor's name and logo will be printed on all the team printed materials including t-shirts, flyers, brochures, roll-ups, banners and etc.
4. Sponsor's name and logo will be printed on the wing of the aircraft in the competition.
5. Sponsor's name and logo will be printed in the graduation project book.
6. Any video related to the team in the competition will include the sponsor's logo and name.
7. The Sponsor has the right to participate in the design process if it is available and to follow up the designing process.

➤ *All points are subject to change upon discussion.*

Requirements

The project needs budget to be implemented and fabricated and the team be able to participate in SAE Aerodesign Competition, therefore Budget analysis is implanted based on the market current prices.

Budget and Cost Analysis

Materials and Components	Pieces	Specifications	Place	Cost
- Balsa Wood Sheets	- 12 sheets - 5 Sheets (100mm X 1000mm)	- 3mm thickness - 8mm thickness	"SAMY store" beside Fine Arts	- 12*60 L.E. = 720 L.E. - 5*70 L.E.= 350 L.E.
- Ply wood sheets	- 4 Sheets - 4 Sheets (244mm X 122mm)	- 3 mm thickness - 6 mm thickness	Abo El - Dordar	- 4*86 L.E. =344 L.E. - 4*160 L.E. =640 L.E.
- Balsa Rods	- 20 Rods	- 7mm Diameter X 1000 mm Length	"SAMY store" beside Fine Arts	- 20 * 40 = 800 L.E.
- Aluminum bars	- 2 bars (2 X 2 cm)	- 6m Length	Abo El - Dordar	- 2*70 = 140 L.E.
- Carbon fiber sheet	- 1 sheet	- 200*500*1mm	Ebay.com	- 32\$ = 592 L.E.
- Carbon Fiber Rods	- 4 Rods	- 9.5mm diameter * 500mm	Ebay.com	- 4 * 15\$= 60\$ = 1110 L.E.
- Landing Gear	- 1 Piece - 2 pieces - 1 piece	- Carbon fiber strut - Wheels - Front wheel	Ebay.com	- 60\$ = 1110 L.E. - 16\$= 296 L.E. - 10\$ = 185 L.E.
- Epoxy	- 10 Units	- Clear Epoxy	Shop	- 10*60 = 600 L.E.
- CA Glue	- 20 units	- Premium Super Glue - Best Cyanoacrylate Adhesive	Shop	- 20*2 = 40 L.E.
- Monokote - Monokote heat Gun	- 8 rolls - 1 Piece	- Top Flite Monokote Opaque Insignia Blue 26 x 72	Amazon.com	- 25.5\$ X 8 =204\$ =3774 L.E. - 23\$ = 425.5 L.E.
- Fabrication processes (Cutting-Turning- Wages - 3D printing)	- All sheets - About 50 gm	- Laser Cutting Turning + wages - 3D Printing	- Abo El - Dordar - Robota	- About 2000 L.E. Total - 16 L.E. for 1gm *50 = 800 L.E.
- Motor + Propeller + Speed Controller	- 1 Piece	- 1000 watt	Shop	- 5000 L.E.
- Remote Control + Receiver	- 1 Piece	- GR Japanese- Fail safe option	Shop	- 10000 L.E.
- Servo Motor	- 8 Pieces	- 10 Kg.cm	Future Shop	- 270*8 = 2160 L.E.
- Propulsion system Battery - Charger	- 1 Piece - 1 Piece	- Li-Pol Battery pack 5000mA & 25c & 22.2V & 6 cells - Smart Charger (1.5A) for 22.2V Li-ion/Polymer	- Horizonhobby.com - Batteryspace.com	- 230 \$ + 120 \$ shipping =350 \$ = 6475 L.E. - 100\$ + 60\$ shipping = 2960 L.E.
- Radio system battery	- 1 Piece	- 1300 mA , 6s, 22.2V, 70c, LiPo	Horizonhobby.com	- 82\$ + 30\$ shipping = 2072 L.E.
- SAE Power limiter V2 2016	- 1 Piece	- Limiter 1000w	neumotors.cartloom.com	- 50\$+25\$ shipping = 75\$ =1387.5 L.E.
- Electric Wires	- According to the electric components	- According to the electric components	Hamada Electronics	- About 200 L.E.
- Bolts + Nuts + Joins	- According to the fixation methods	- According to the fixation methods	- Abo El - Dordar	- About 500 L.E.

- Back Up Materials and components				- 30000 L.E.
- Customs	20 T-shirts			- About 2000 L.E.
- Plane Shipping from Egypt to USA				- 8000 L.E.
- Tickets	6 ticket (13,000 – 16,000 L.E.)	British Airways or Egypt air		- 78,000-96,000 L.E.
- House rental in USA for 7 days		Airbnb.com Booking.com		- \$1000 = 18,000 L.E.
- Car rental in USA		Avis.com Enterprise.com		- \$700 = 12,600 L.E.

Fabrication fees = 77,700 EGP

Travelling fees = 134,600 EGP

Total = 212,300 EGP

Pegasus Aerodesign history

- The **9th place** at **SAE Aero design west competition 2017** AT Texas USA.
- (*PEGASUS team is the first Egyptian team to be one of the top ten and achieving the ninth place in the SAE Aero Design Competition that contains 75 teams from the top universities around the world*).
- The **21st place** at **SAE Aero design west competition 2016** AT Texas USA.
- The **3rd Place** at **UAVC competition 2017** at Egyptian military college.
- Pegasus has participated in the **Military Technical College projects fair 2016**.
- Pegasus has participated in **MAC-TECH fair 2016**.
- Pegasus has participated in **EED projects fair 2017**.
- Pegasus has participated in **ITW conference's gallery 2017** that organized by IEEE Alex Student chapter.
- Pegasus has participated in **International Cairo Exhibition of Innovation 2017**.

Pegasus in Media

- <https://goo.gl/dSnNss> برنامج على ذمة التحقيق - صدى البلد :
- <https://goo.gl/Mw1QAD> برنامج من ماسبيرو – القناة الاولى :
- <https://goo.gl/YRa1zL> برنامج الطبعة الاولى – قناة دريم :
- <https://goo.gl/WRi1NS> اليوم السابع :
- <https://goo.gl/p2bkX8> جريدة الوطن :

الإسكندرية - مروة مرسي:
 قال فريق من قسم الميكانيكا بكلية الهندسة جامعة الإسكندرية بالمرکز الاتّصاع في سابقة عالية أقيمت بالولايات المتحدة الأمريكية بمشاركة 20 جامعة من دول العالم، أن فريق طائفة تلعب بالتحكم بعد، وبلغ الفريق المكون من 8 أعضاء من بينهم 4 طالبات، عقب فوزهم بالمرکز الاتّصاع، بعد أن فازوا بسبعة أشرفان التتويج، لإيجاد آدم الأستاذ المساعد بقسم الميكانيكا، كلية الهندسة، بالجامعة العزيزة تقصيص، عميد كلية الهندسة، بالجامعة، «الوطن»، التي ترفع الفرق الطلابية من خلال نادي الإبداع الإسلامي الذي أنشئ العام الماضي لتلبي الطلّاب الموهوبين والبدیعین ومساعدتهم في