AEROSP 215 **Open-Ended Problem 1** **Written part due 2/1/19 at 8:30 am**
Winter 2019 **Mandatory in-class discussion on 2/1/19**

Possible points: 50

The *Lesher Nomad*, currently on display in the FXB atrium, is an experimental two-place aircraft designed and built by Edgar J. Lesher.

Lesher was born in 1914 in Detroit, Michigan. Although he completed his bachelor's degree and pursued graduate studies at Ohio State University, he completed a master's degree in Aeronautical Engineering at the University of Michigan in 1940. Lesher joined the department as a faculty member in 1942, retiring from the University of Michigan in 1985.

Lesher designed and built the *Lesher Nomad*, an all-aluminum, pusher propeller aircraft between 1958 and 1961. The first run was completed in 1962 at Willow Run Airport in Ypsilanti. The aircraft was flown regularly until Lesher's death in 1998.

We are going to be analyzing this aircraft throughout the course. In doing so, we will make many assumptions of varying validity. Pay attention to these assumptions and note how they could be improved.

There are two parts to this assignment:

- A written part (on the next page), which is due to Gradescope on Friday, Feb. 1 at 8:30 am. This part is worth 40 points, broken down as such:

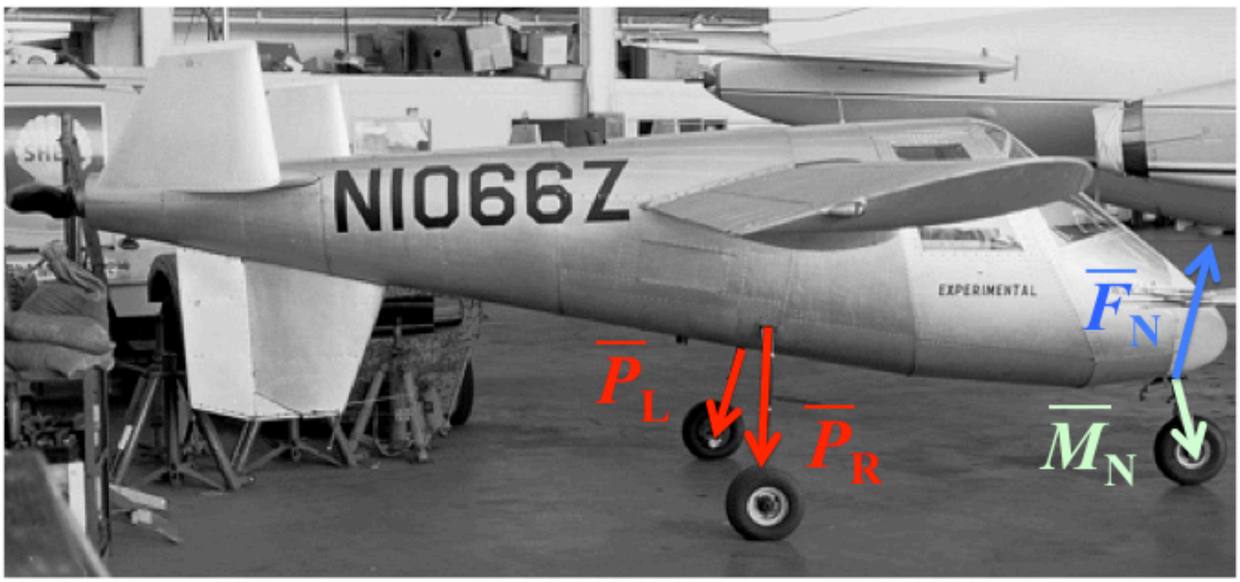
Part	**1**	**2**	**3**	**4**	**5**
Points	3	20	10	5	2

- Participating in a small-group discussion during class on Friday, Feb. 1. You should bring a copy of your written work to this discussion, as you'll be working with a small group of other students to compare your models of the *Nomad* and develop a group model that's better than any of your individual models. This part is worth 10 points.

Model 1: The Main Landing Gear as Statically-Determinate Rigid Two-Force Members

When the *Nomad* is touching the ground, its three landing gear support the *Nomad*'s weight and, potentially, the effect of other forces and moments. To make a first approximation of the forces within the landing gear, we will model the bars of the main (rear) landing gear as rigid two-force members with circular cross-sections. We will not model the bar of the nose landing gear as a two-force member because if we do, the math doesn't work out in many cases. Instead, we will model the joint where the nose landing gear connects to the fuselage as "universal joint" that can carry a reaction force vector with an unknown direction and a reaction moment vector with a known direction that is aligned with the nose landing gear.[1]

The figure below shows the notation you should use for the reaction force vector at the nose landing gear ($\bar{F}_N$), the reaction moment vector at the nose landing gear ($\bar{M}_N$), and the axial force vectors for the main landing gear on the pilot's left ($\bar{P}_L$) and right ($\bar{P}_R$) sides. You will be solving for these four unknown vectors.



In this problem, you should imagine that you're Ed Lesher and are sizing the landing gear for actual operations. In other words, you should try to think about the operational scenario that puts the greatest load on the landing gear (e.g. *not* sitting unused in the FXB atrium, in flight, etc.).

Answer the following questions:

1. We've assumed that the bars of the main landing gear are modeled as two-force members. What does this imply about the way we're inherently modeling 1) the joint between these two landing gear bars and the fuselage, and 2) the joint between the landing gear bars and the wheels? Is this true-to-life?

[1] The joint where the nose landing gear connects to the fuselage is the same type of joint as the one at point *A* in problem 5 of homework 1.

2. Make a free-body diagram of the *Nomad* without its landing gear that includes:
   - The four unknown vectors:
     - The reaction force vector at the nose landing gear, $\bar{F}_N$
     - The reaction moment vector at the nose landing gear, $\bar{M}_N$
     - The internal force of both main landing gear bars, $\bar{P}_L$ and $\bar{P}_R$
   - Approximate forces and moments, including any significant self-weight. **Explain all decisions you make.**
   - Dimensions (use the dimensions of the actual aircraft).

   Cite (no particular format needed) all sources that you use for this part.

3. Find numerical answers for the components of the four unknown vectors.

4. Using the Material Properties Reference from Bedford & Liechti (on Canvas in the "References" folder), select a material and diameter for each of the main landing gear bars that you believe is sufficient given the yield stress of your chosen material and an aerospace-appropriate safety factor. **Justify your answers.** Is the size of the bar that you found physically reasonable? Is the size of the bar that you found the same as for the actual *Nomad?* (It may not be.)

   Note that you are not sizing the nose landing gear, as it is not modeled as a two-force member.

5. What other factors beyond just strength might an engineer consider when selecting the material and diameter for the main landing gear bars? Name at least two.

Bonus (5 points)

As is mentioned above, we cannot model the bar of the nose landing gear as a two-force member because if we do, the math "doesn't work out in many cases." This brings up an important conceptual point that makes it hard to write good statics problems (as is evidenced by the changes I had to make to the problem) and is easy to miss (as I originally did).

So, for 5 bonus points on this assignment, write a little bit telling me what it means mathematically and physically that the math "doesn't work out" when you model the nose landing gear as a two-force member. To answer mathematically, tell me how the mathematics break down and what errors arise. To answer physically, tell me what would happen to the *Nomad* if all of its landing gear were two-force members.

Hint: The problem lies with the stability of the system.