First sentence clearly highlights the problem they want to address: climate change

The aviation sector is undergoing its biggest transformation, since the introduction of the jet engine, due to the challenges of addressing climate change.

Highlights their perspective/key attributes that set them apart

From my position in industry, I see the widening gap between requirements that mitigate these challenges and the current capabilities of gas turbines. At my current employer, I am involved in testing new, sustainable fuels, designing hotter and smaller components, and improving models to enable future low emissions technologies.

States a challenge that serves as motivation for their research

However, to meet the industry goal of net-zero carbon dioxide (CO_2) emissions from aviation by 2050, the pace at which solutions are developed and implemented must be accelerated. A critical aspect in achieving this goal is deep aerothermal physical understanding and effectively translating that into technology in an industry environment.

Mentions the school they are applying to and elaborates on their research vision

If I were successful at MIT, a central principle of my research would be the connection between the physical principles and real design that enables this transformation.

Intro

Outlines the statement by focusing on key challenges they will solve

Initially at MIT, I would take on two major challenges for sustainable aviation propulsion. The first challenge is that emissions from gas turbines have a significant impact on global warming.

They motivate their research on a more technical level, and then provides context to why current methods aren't sufficient

Nitrous oxides are a direct greenhouse gas, and soot particles cause contrail formation which also has a global warming effect. There are three technical solutions to these problems: alternative fuels (such as sustainable aviation fuel and hydrogen), low emission rich burn combustor designs, and lean burn architectures. However, each has barriers related to competing emissions sources, combustion stability, and reliability, which have made traditional combustor technology development slow. What I realized when I reentered industry after my PhD was that a fundamental knowledge of turbulence underpins all the important processes in the combustor, from altitude relight to soot formation.

Defines a key research focus; uses more technical words (i.e. mixing rates) to elaborate on this research focus

Unlocking the links between turbulence and mixing rates can thus accelerate the development of all three solutions.

To understand these links, one method I would employ to accelerate my research is rapid prototype testing of designs on a non-combusting rig, tracing different gases to map the flow distribution. These studies could progress straight into an actual combustor test, either on a rig or on an engine, to measure performance and emissions with different fuels, enabling a rapid transition from fundamental physical understanding to high technology readiness level (TRL) and the ability to provide insight in a field which is still not fully understood.

Situates their research within the department, and identifies possible labs they can collaborate with

Further, the multi-discipline nature of emissions research provides excellent opportunity for collaboration across MIT laboratories, departments, and disciplines; examples might be the Department of Chemical Engineering on alternative fuels and the Laboratory for Aviation and the Environment on global environmental impacts.

Signposting to make the next area easy to find

The second challenge I aim to tackle is increasing efficiency of the next generation of engines. This generation will have smaller cores (gas generators), around 60% of current engines, and hotter temperatures. As core sizes drop, engine component efficiency falls rapidly, and hotter temperatures require larger percent cooling flows, further increasing fuel consumption. Additive manufacturing provides a means to unlock improved aerothermal performance through combining optimization of thermal load with viscous processes. My second area of research is thus the role of additive manufacturing in enabling novel aerothermal architectures. From my experience designing the hottest engine parts in industry, the difficulty of a new design paradigm lies not only understanding the physical mechanisms that govern aerothermal performance, but also gaining the knowledge on how to manufacture a design with sufficient life and integrity.

Highlights a specific avenue of collaboration

At MIT, I would link my experience in aerothermal design with additive manufacturing researchers to create designs for practical components that exceed the current limitations.

In addition to component level changes, there are also bigger architectural changes on the horizon for aviation propulsion. Future propulsors may no longer only be pods under wings but could be embedded in the body of the aircraft or distributed on the wing. A third challenge I will address is aerodynamic integration of aircraft and propulsor. My work in combustor turbulence has shown that an important and little understood area is the interaction of large turbulent flow structures with boundary layers. This is true from large scale turbulence in the atmosphere down to airframe turbulence. Given my background and experience, this is a field in which I can make a large contribution.

Understanding how the flow structures of the aircraft and propulsor interact with boundary layers will require new measurements to explore a field that has not been studied from this perspective.

Highlights an example research project that they could pursue

My unique experience with the assessment of highly complex flows, along with expertise in boundary layer measurements, provide an opportunity to support the work I have seen emerging from MIT on EVTOL concepts and boundary layer ingestion. A possible example is experimental work in the new Wright Brothers wind tunnel to understand the effect of propulsors on wing stall and of boundary layer ingestion on fan performance. These experiments would naturally link with computational modeling being developed at the MIT Aero Astro Department.

In summary, my research interest in aerospace environmental impact mitigation is directly aligned with the Department's long term research strategy.

Summarizes their specific strengths and their alignment with the department

It complements and broadens the Department's current strengths while addressing future changes to the aerospace field. I hope to bring my demonstrated capability for conducting world class research, my decade of experience working in the aerospace industry, and my passion for sustainability to the MIT Aero Astro Department. If successful, I would combine practical industry experience with deep fundamental understanding to "push the boundaries of the possible to ensure lasting positive impact on our society, economy, and environment."