Team 7: AVION, A2

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I. Conceptual Designs

A. Drawings

1. Concept 1

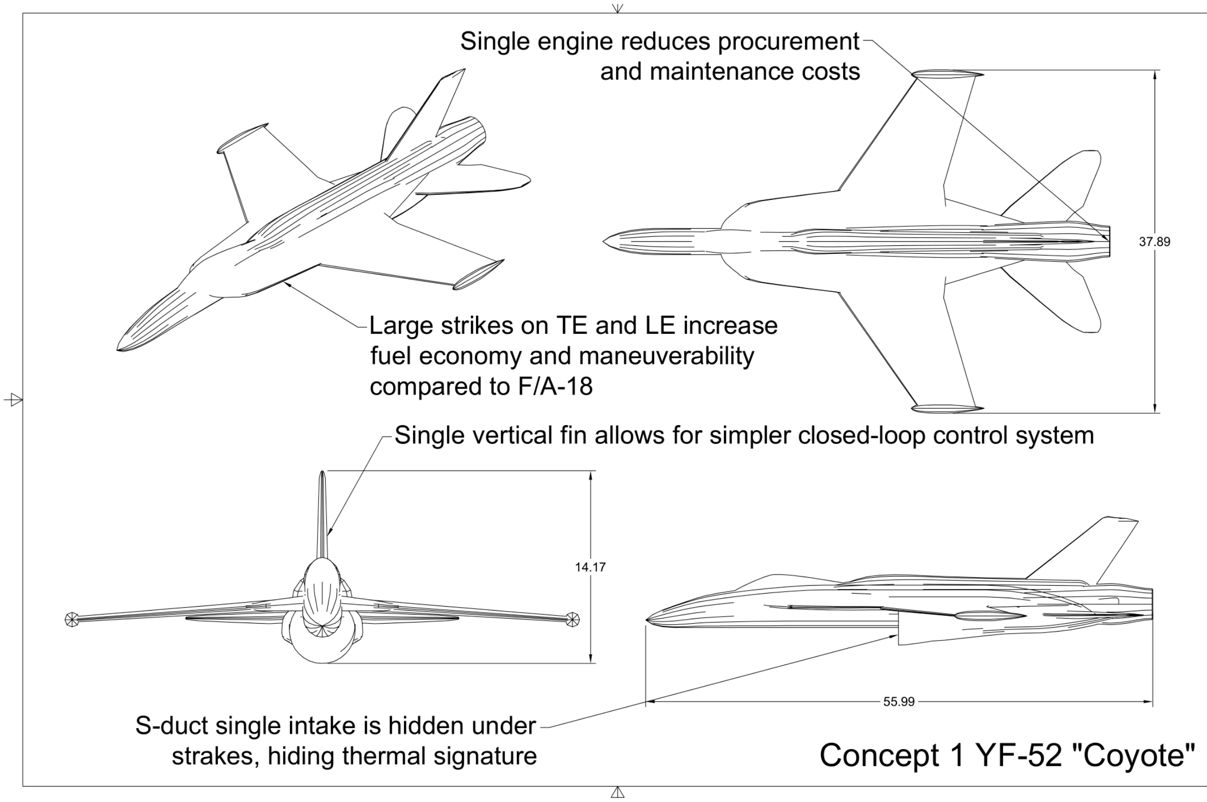

Figure 1. 4-View Drawing of Concept 1 - YF-52 Coyote

2. Concept 2

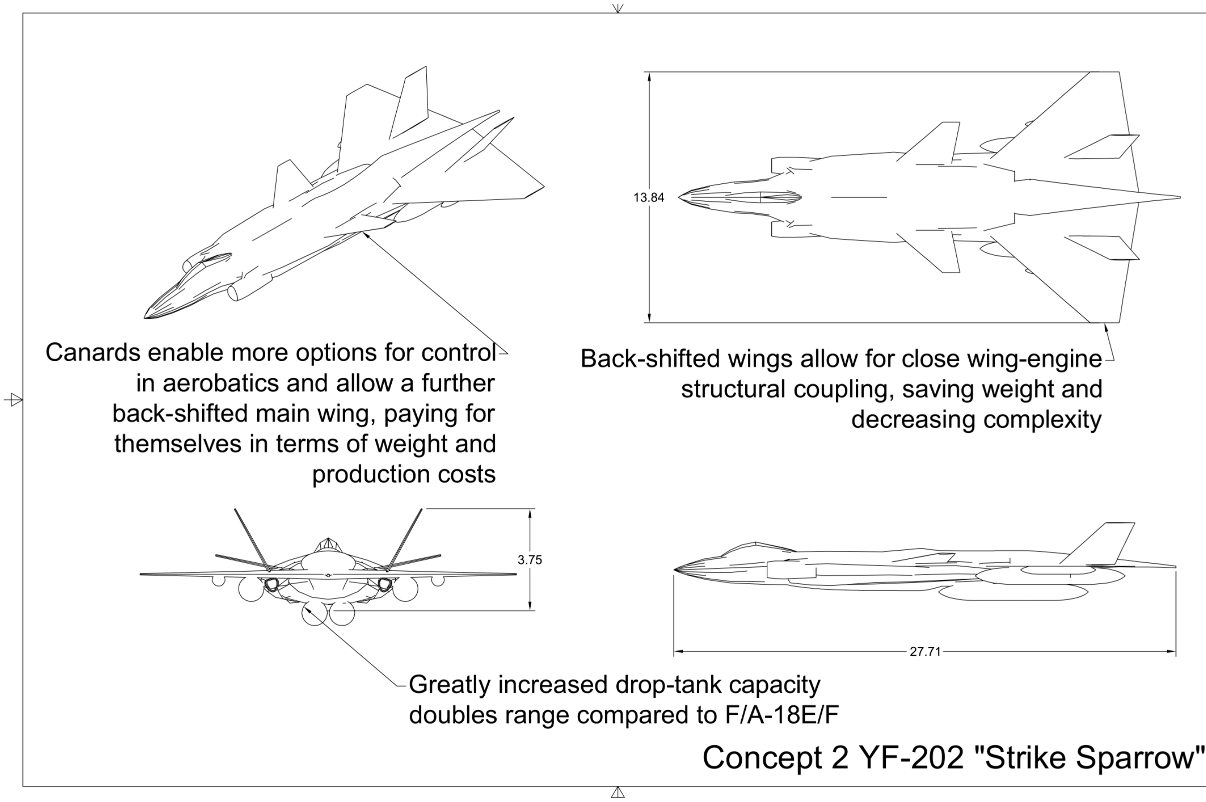

Figure 2. 4-View Drawing of Concept 2 - YF-202 Strike Sparrow

B. Design Innovations

1. Concept 1

Concept 1, dubbed the YF-52 ”Coyote”, is a single engine, single seat air superiority/strike fighter that prioritizes affordability in acquiring and maintenance. Taking design notes from the F-5 Tiger II, the F-18 Hornet/Super Hornet, and the Dassault Mirage, the design aims to preserve the dual-function capability of the F18E/F Super Hornet while cutting the costs involved with operation. The long leading edge and trailing edge strakes add lifting body-like characteristics (allowing a more efficient cruise and more advanced manuverability) to the otherwise thin fuselage, and helps to hide the engine’s thermal signature from both ground and above air adversaries. Composite materials used in the airframe and aerodynamic surfaces will save weight and cost. The leading edge/trailing edge root extension can also be thickened to provide extra space for fuel and internal weapon stores. Simple flap systems on the main wing work to control approach speeds for carrier operations. A single vertical stabilizer, as opposed to the twin vertical stabilizers commonly found on twin-engine jet fighters, provides structural weight savings and cost savings. In addition, dorsally mounted fuel tanks extend the aircraft range, allow it to scramble to its missions faster.

2. Concept 2

Concept 2, the YF-202 “Strike Sparrow” is a twin-engine, single-seat multirole fighter concept inspired by the J-20 platform philosophy, emphasizing high-lift control, mission flexibility, and survivability while remaining compatible with carrier operations. The aircraft features a wide fuselage with twin engine intakes and nozzles, supporting increased internal volume for fuel, avionics, and structural reinforcement, which is an advantage for meeting long-range mission requirements and heavier bringback conditions while improving stability and packaging efficiency. The configuration includes two vertical stabilizers for improved high-angle-of-attack directional control and enhanced yaw authority, and two canards placed forward of the main wing to increase lift at low speed, strengthen pitch response, and reduce approach speeds during carrier recovery. The single main wing provides the primary lifting surface, while the canard-wing interaction can generate additional vortex lift for controlled performance across both slow-speed and high-speed regimes. To further enhance carrier recovery and slow-speed handling, the ”YF-202” incorporates aggressive flaps and leading-edge high-lift devices, increasing the effective coefficient of lift without requiring an oversized wing footprint. Additionally, the design assumes a reduced reliance on composite materials in external aerodynamic surfaces, which can simplify control of radar reflections and improve compatibility with stealth-focused shaping and coatings. Finally, the fuselage incorporates a tail extension approximately 1 ft beyond the aft end of the main wing, improving aerodynamic flow shaping at the rear body, offering additional internal space for equipment or cooling/thermal management, and contributing to improved stability and control at high speed by helping manage base drag and wake behavior behind the aircraft.

II. Quantitative Comparison Metrics

A. Weight Comparison

1. Concept 1

The preliminary weight estimation for Concept 1, sized to satisfy both air-to-air and strike mission requirements, yields an estimated takeoff gross weight of approximately 53,473 lb, with an associated empty weight of 32,948 lb, corresponding to an empty-weight fraction of 0.62. This gross weight places Concept 1 in the same class as modern carrier-based multirole fighters, indicating that the configuration is directionally realistic for naval operations. However, the relatively high empty-weight fraction reflects the combined effects of carrier suitability and the inclusion of substantial internal avionics and payload capacity, suggesting an airframe in line with current fighter trends. At the same time, the total fuel fraction is reported as 0.3059.

2. Concept 2

The preliminary weight estimation for Concept 2, sized to satisfy both air-to-air and strike mission requirements, yields an estimated takeoff gross weight of approximately 72,557 lb, with an associated empty weight of 44,594 lb, corresponding to an empty-weight fraction of 0.61. This gross weight places Concept 2 in the same class as modern carrier-based multirole fighters, indicating that the second concept is also directionally realistic. However, the relatively high empty-weight fraction reflects the combined effects of carrier suitability, twin-engine configuration, and the inclusion of substantial internal avionics and payload capacity, suggesting a structurally heavy design. At the same time, the total fuel fraction of 0.3160.

B. Cost Comparison

1. Concept 1

A program-level cost estimate for Concept 1 was performed using the Modified DAPCA IV cost model, which decomposes total cost into labor-based and materials-based components as a function of empty weight, maximum speed, and production quantity. For an estimated empty weight of W_e = 32,948 lb and a maximum speed of Mach 1.6 at 30,000 ft ($V \approx 943$ kt), the total labor cost associated with engineering, tooling, manufacturing, and quality control was estimated at approximately $14.1 B (2026 USD). Additional cost terms, originally expressed in 2012 USD and inflated to 2025 USD [1, 2], include development support ($0.67 B), flight testing ($0.20 B), manufacturing materials ($4.58 B), engine production ($11.98 B for a two-engine configuration), and avionics ($0.04 B). Summing all components per using the DAPCA IV governing equations (Eq. 18.9 in the Raymer textbook) [3] yields a total program cost (RDT&E plus flyaway) of approximately $31.6 B for a 500-aircraft production run, corresponding to an average cost of $63.2 M per aircraft. These results are consistent with expectations for a high-performance, carrier-capable tactical aircraft and reflect the inclusion of propulsion, avionics, and non-recurring development costs within the DAPCA framework.

2. Concept 2

A program-level cost estimate for Concept 2 was performed using the Modified DAPCA IV cost model as well. For an estimated empty weight of $W_e = 44{,}594$ lb and a maximum speed of Mach 2.0 at $30{,}000$ ft , the total labor cost associated with engineering, tooling, manufacturing, and quality control was estimated at approximately $18.0 B (2026 USD). Additional cost terms, originally expressed in 2012 USD and inflated to 2025 USD [1], include development support ($0.81 B), flight testing ($0.22 B), manufacturing materials ($6.06 B), engine production ($20.8 B for a two-engine configuration), and avionics ($0.04 B). Summing all components per Eq. (18.9) [3] yields a total program cost (RDT&E plus flyaway) of approximately $45.9 B for a 500-aircraft production run, corresponding to an average cost of $91.9 M per aircraft. These results are consistent with expectations for a dual mission, carrier capable tactical aircraft with ample internal volume and exotic aerodynamics, and reflect the inclusion of propulsion, avionics, and non-recurring development costs within the DAPCA framework. A reasonable cost estimate (based on historical fighter procurement and academic cost modeling) of the RDT&E phase would be on the order of $25–30 billion, reflecting the advanced stealth, avionics, and carrier-integration development costs typical of modern combat aircraft programs, as shown in fighter RDT&E cost studies and hedonic cost models of aircraft characteristics [4].

III. Qualitative Comparison Metrics

A. Selection of Key Metrics and Weighting

The qualitative metrics chosen reflect the main limitations and objectives denoted in the RFP, balancing cost feasibility, long term viability, and combat capability. Mission effectiveness is weighted the highest along with affordability as the fighter aircraft must efficiently perform strike and air to air missions while meeting requirements for dash speed, combat radius, payload carriage, and maneuverability. Affordability is weighed as heavily as mission effectiveness as a principal objective in the RFP is to create a fighter aircraft with improved capability at a comparable and lower unit acquisition cost, attempting to fight against historical trends of raising aircraft procurement costs. Survivability is included with moderate weight to capture the advantages of vulnerability reduction and operational durability in advanced threat environments. Maintainability is incorporated to consider the ease of life cycle maintenance and reliability vital to long term carrier operations in a maritime setting. Variant potential is the lowest weight yet used to compare the fighter's ability to adapt to future upgrades, changing mission requirements, and differing payloads through margins in power, volume, and cooling. This coincides with the RFP's incentive to create future variants and additional operational roles for our chosen design.

B. Pugh Matrices

Table 1. Weighted Pugh matrix comparing Concept 1 and Concept 2 against the F/A-18E/F datum

Qualitive Metrics	Weight	F/A-18E/F	Concept 1	Concept 2
Mission Effectiveness	0.3	0	0	+1
Affordability	0.3	0	+1	-1
Survivability	0.2	0	-1	+1
Maintainability	0.15	0	+1	-1
Variant Potential	0.05	0	-1	+1
	Tot +1		2	3
	Tot 0		1	0
	Tot -1		2	2
	Weighted Overall		+0.2	+0.1

C. Selection of Concept

Both concepts were evaluated using a weighted Pugh matrix to compare their weaknesses and strengths against the F/A-18E/F datum. Concept 1 emphasizes maintainability and affordability through reduced airframe, simple single engine design, and fewer complex systems. This resulted in a lower maintenance burden and acquisition cost relative to Concept 2 and the datum. These advantages are in the highest weighted metrics, making them consequential drivers in the overall analysis. Concept 1's weight overall is lowered by variant potential and survivability due to limited internal volume and minimized propulsion redundancy. Concept 2 shows better mission effectiveness, variant potential, and survivability through a twin engine design with a larger internal volume and enhanced high lift and control authority. These innovations improve redundancy, performance margins, and long term flexibility yet lead to a larger maintenance burden, higher acquisition cost, and greater system complexity. This resulted in a negative rating for affordability and maintainability. The final weighted scores show that Concept 1 results in a higher overall value (+0.20) compared to Concept 2 (+0.10), with most of its advantages concentrated in the heavily weighted metrics. Hence, Concept 1 will be further developed as it balances the required mission capability with cost control, sustainment, and operational practicality in alignment with the RFP priorities.

IV. Appendix

A. CRediT Statement

Mostafa Hashem: Conceptualization. Design. Visualization. Concept 2 Development. Drawings. **Charlie Stone:** Concept 1 Development. Conceptualization. Drawings. Visualization. **Valeria Cecena:** Pugh Matrix. Selection of Concept. Conclusion. Model Comparison. **Quinn Kennerly:** Weight Comparison Concept 2. Administration and Analysis. **Lena Pattamadilok:** Weight Comparison Concept 1. Cost Comparison and Analysis. Formatting. Cost Code Development. **Jose Hernandez Negrete:** Model Comparison. Pugh Matrix. Visualization.

B. AI and Code Use Statement

AI was used to debug the cost code. Chat GPT was implemented to check grammar.

References

[1] "Consumer Price Index, 1913-," Tech. rep., Federal Reserve Bank of Minneapolis, Minneapolis, MN.

[2] "Consumer Price Index for All Urban Consumers: All Items in U.S. City Average," Tech. rep., U.S Bureau of Labor Statistics.

[3] Raymer, D. P., *Aircraft Design: A Conceptual Approach*, American Institute of Aeronautics and Astronautics, Reston, VA, 6th ed., 2018.

[4] Stelly, J. M., *Price vs. Performance: The Value of Next Generation Fighter Aircraft*, Dissertation, Air Force Institute of Technology, March 2007.