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Aerodynamic Feasibility Study on Highly Distributed Lifting Configurations for Aircraft

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Feasibility Study on Highly Distributed Lift Configurations

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Problem

Current Monoplane Configurations:
- Are Less Maneuverable Than They Could Be
- Take Up A Lot Of Space Due To Long Wingspan
- Wings Are Significant Contribution To Aircraft Weight
- Wings Cost A Lot To Manufacture And Repair

Proposed Solution

Reduce Span Size By 2 Orders Of Magnitude:
- Distributed Lift Across Numerous Smaller Wings
- Provide Much Greater Maneuverability
- Cost Less To Manufacture And Repair
- Are Considerably More Damage Tolerant

Previous Research

- Biplane Research Looked At The Effects Of Gap And Stagger On The Coefficient Of Lift (CI)^3
- Lower Lift From Lowering Aspect Ratio Negated With Increased Wing Count Downstream^2
- Single Layer Multi-wing With Varied Stagger Focused On Cl To Angle Of Attack Relationship^2

Methodology

- Design Multi-wing Configurations With Same Overall Wing Area As Conventional Monoplane
- Use Vortex Lattice Method (VLM) Software To Model And Test For Cl And Cd At Angles Of Attack
- Goal Is Max L/D Of Multi-wing Close To That Of Monoplane
- Once Meaningful Results Are Found In VLM Software, 3D Models Tested In Wind Tunnel
- Test With Varying Span To Look At How Vorticity Effects L/D Of System, Increase Angle Of Attack Of Downstream Wings, And Vary Gap And Stagger Of Multi-layer Wing Sets

Results

- Agreement Of VLM Data And Experimental Data In Single Layer Configurations
- In Most Cases Increasing Gap And Stagger Improved L/D
- To Keep Design Compact, Configurations With Minimum Spacing Will Be Investigated

Conclusions

- Variations In Downstream Incidence Angle And Span Did Not Show Results Close To That Of The Monoplane
- Single Layer Stagger Variation Around 75% Of Monoplane
- 4 Layer Gap And Stagger In Configurations With Gaps Above 10C Show 90% Of Monoplane L/D
- The 4-wing Configuration Results Were Relevant In Software Modeling and Wind Tunnel Testing Verified These This But On A Smaller Scale.
- Meaningful Next Step Is Study Into Downstream Interactions On Wings And Effective L/D Changes Due To Interactions To Enable Increased Columns Of Gap And Stagger Wing Sets

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