Abstract: An aircraft's two wings and joined thruster propellers or turbines serve as rotary wings in helicopter mode and as fixed wings in airplane mode. The thrusters along the wingspans or at the wing tips drive both rotary wing rotation and airplane flight. Large-angle controlled feathering about the pitch change axes of the left and right wings and thrusters allows them to rotate, relative to each other, between facing and thrusting forward in the same direction for airplane flight or facing and thrusting oppositely for helicopter flight. Optional controls include: helicopter cyclic and collective pitch; airplane roll by differential wing pitch; yaw by differential prop thrust; fuselage pitch by wing pitch change and prop thrust change interacting with an underslung craft e.g.; and fuselage yaw control independent of rotor rotation via a powered rotary mast coupling or a tail responsive to rotor downwash. A teetering rotor hub is a further option.
1. An aircraft capable of (a) sustained powered rotary-wing-mode VTOL flight and (b) sustained powered non-rotary forward airplane-mode flight, the aircraft comprising:
   a hub;
   a pair of wings coupled to the hub and serving as both rotary wings in rotary-wing-mode VTOL flight and as a pair of lifting wings in airplane-mode flight;
   a fuselage coupled to the hub and located under the pair of wings when the aircraft is in said rotary-wing-mode VTOL flight and in said non-rotary forward airplane-mode flight; and
   a propulsion component configured to provide propulsion for the aircraft sufficient for sustained powered flight, wherein the propulsion component includes a plurality of thrusters including at least one thruster on each wing of said pair of wings, wherein said plurality of thrusters provide sustained rotation of the pair of wings in said rotary-wing-mode VTOL flight and sustained forward motion of the pair of wings and of the entire aircraft in said non-rotary forward airplane-mode flight,
   wherein said at least one thruster on a first one of said pair of wings is able to thrust in substantially an opposite direction from propulsion from said at least one thruster on a second one of said pair of wings in said rotary-wing-mode VTOL flight and,
   wherein said propulsion from said at least one thruster on said first one of said pair of wings is able to thrust in substantially a same direction as propulsion from said at least one thruster on said second one of said pair of wings in said non-rotary forward airplane-mode flight.

2. The aircraft of Claim 1, wherein each of said plurality of thrusters is an unshrouded propeller.

3. The aircraft of Claim 1, wherein each of said plurality of thrusters is a shrouded turbine.

4. The aircraft of Claim 1, wherein propulsion from each of said plurality of thrusters is varied differentially in said non-rotary forward airplane-mode flight to control yaw rotations of said aircraft,

5. The aircraft of Claim 1, wherein, in a transition between said rotary-wing-mode VTOL flight and said non-rotary forward airplane-mode flight, said at least one thruster on said first
one of said pair of wings is affixed to said first one of said pair of wings and rotates in a feathering rotation with said first one of said pair of wings about a pitch change axis of said wing, said pitch change axis being substantially parallel to a span of said first one of said pair of wings, and where said at least one thruster and said first one of said pair of wings rotate in said feathering rotation through an angle change exceeding about 120 degrees relative to said hub.

6. The aircraft of Claim 5, wherein said hub is located between said pair of wings and attached to each wing of said pair of wings, wherein an attachment between said pair of wings permits feathering rotations in both wings about said pitch change axes of each of said two wings, and wherein:

said feathering rotations control aircraft roll in said non-rotary forward airplane-mode flight; and,

said feathering rotations control variations in a plane of rotation of said pair of wings in said rotary-wing-mode VTOL flight.

7. The aircraft of Claim 6, wherein said attachment between said pair of wings controls and powers said feathering rotations.

8. The aircraft of Claim 6, wherein said plurality of thrusters on said pair of wings cause gyroscopic torsions acting on said pair of wings about the respective pitch change axes of said pair of wings when operating in said rotary-wing-mode VTOL flight, said gyroscopic torsions being controllably varied cyclically in a one-per-rev cycle to augment or entirely effect said feathering rotations to control said variations in said plane of rotation in said rotary-wing-mode VTOL flight.

9. The aircraft of Claim 8, wherein each one of said thrusters includes at least two rotary propeller or turbine components rotating in substantially opposite vector rotation senses, wherein:

variable angular momenta arising from said substantially opposite vector rotation senses at least partially cancel one another; and,

said gyroscopic torsions about said pitch change axes, arising from said variable angular momenta in rotary-wing-mode VTOL flight, are controllably varied through alteration of said
substantially opposite vector rotation senses, thereby acting to said augment or entirely effect said feathering rotations.

10. The aircraft of Claim 9, wherein said at least two rotary propeller or turbine components of each of said thrusters provide independently variable thrust vectors acting through differing moment arms with respect to the associated one of said respective pitch change axes, whereby a variable wing-pitch-control moment arising from said independently variable thrust vectors and differing moment arms controls wing pitch in said non-rotary forward airplane-mode flight.

11. The aircraft of Claim 6, wherein said fuselage is a normally non-rotary fuselage with rotatable attachment to said hub, wherein said fuselage maintains a controllable non-rotary yaw angle in said rotary-wing-mode VTOL flight.

12. The aircraft of Claim 11, wherein said rotatable attachment to said hub includes torsion actuation operating through said rotatable attachment to control said non-rotary yaw angle.

13. The aircraft of Claim 11, including controllable aerodynamic thrust in said fuselage, said controllable aerodynamic thrust acting through a radius from an axis of said rotatable attachment for said maintaining a controllable non-rotary yaw angle.

14. The aircraft of Claim 13, wherein said controllable aerodynamic thrust acting through a radius is provided by a tail component undergoing angular changes, said angular changes interacting with downwash from said pair of wings to provide said controllable aerodynamic thrust acting through a radius.

15. The aircraft of Claim 11, including decoupling and re-attachment of said rotatable attachment, whereby said hub can fly independently of said fuselage or with said rotatable attachment to carry said fuselage.

16. The aircraft of Claim 11, including tilt-angle decoupling between said fuselage and said pair of wings, whereby said plane of rotation of said pair of wings can tilt in pitch and roll directions independent of pitch and roll angles of said fuselage.

17. The aircraft of Claim 16, wherein said tilt-angle decoupling includes a flapping hinge in said hub, allowing said pair of wings to flap through variable angles with respect to said hub.
18. The aircraft of Claim 16, wherein said tilt-angle decoupling includes a universal hinge permitting rotation and suspension of said fuselage at arbitrary suspension angles in pitch and roll with respect to said plane of rotation,

19. A method for controlling an aircraft in a rotary-wing-mode of flight and an airplane-mode of flight and in transitions between said rotary-wing-mode of flight and said airplane-mode of flight, the method comprising the steps of:

- independently controlling pitch angles of each of two wing-plus-thruster systems of the aircraft in feathering about their respective wing-pitch-change axes, including feathering to cause angle changes exceeding about 120 degrees relative to a hub of the aircraft;
- controlling said pitch angles to direct said two wing-plus-thruster systems over a range of angles in approximately opposite directions for said rotary-wing-mode of flight;
- controlling said pitch angles to direct said two wing-plus-thruster systems over a range of angles in an approximately same direction for said airplane-mode of flight;
- controlling said pitch angles in said approximately opposite directions cyclically to control rotary-wing-mode plane of rotation;
- controlling said pitch angles in said approximately same direction to control aircraft roll in airplane-mode flight;
- controlling said pitch angles continuously in flight in transition from said approximately opposite directions to said approximately the same direction for transition from said rotary-wing-mode to said airplane mode;
- controlling said pitch angles continuously in flight in transition from said approximately the same direction to said approximately opposite directions for transition from said airplane-mode to said rotary-wing-mode; and,
- controlling angular speeds of the thrusters of said two wing-plus-thruster systems differentially and cyclically in said rotary-wing-mode of flight in a one-per-rev cycle, thereby cyclically varying gyroscopic wing-pitching moments in said thrusters to control wing cyclic pitch.
20. The method of Claim 19, further including independently controlling thrusts of said two wing-plus-thruster systems differentially in said airplane-mode of flight for controlling aircraft yaw.

21. A method for controlling pitch angles of a pair of wings with corresponding attached thrusters, said pair of wings being joined to a control hub and constituting an aircraft, each wing and thruster combination being capable of independent pitch angle rotation through large angles under servo control, the method comprising the steps of:
   - determining a target common-mode lift from said pair of wings;
   - determining a target differential-mode lift from said pair of wings;
   - determining indicated airspeeds of said pair of wings;
   - determining, from said indicated airspeeds, from said target common-mode lift and from said target differential-mode lift, target theoretical lift coefficients for said pair of wings;
   - determining actual lift coefficients of said pair of wings; and
   - servo controlling the pitch angles of said pair of wings to cause said actual lift coefficients to approach said target theoretical lift coefficients.

22. The method of Claim 21, wherein said target differential-mode lift is varied cyclically at a one-per-rev rate, synchronized to rotations of said aircraft in a rotary wing mode, thereby to control a plane of rotation of said aircraft.

23. The method of Claim 21, wherein if one of said indicated airspeeds of said pair of wings falls below a predetermined threshold, then said servo controlling of the pitch angles will revert to an alternate control method.

24. The method of Claim 21, further comprising the step of limiting said target common-mode lift and said target differential-mode lift to magnitudes achievable within aerodynamic capabilities of said pair of wings.

25. The method of Claim 23, wherein said alternate control method controls vector forces of said attached thrusters.

26. An aircraft capable of (a) sustained powered rotary-wing-mode VTOL flight and (b) sustained powered non-rotary forward airplane-mode flight, the aircraft comprising:
   - a hub;
a pair of wings coupled to the hub and serving as both rotary wings in said rotary-wing-mode VTOL flight and as a pair of lifting wings in said non-rotary forward airplane-mode flight; and

a propulsion component configured to provide propulsion for the aircraft sufficient for sustained powered flight, wherein the propulsion component includes a plurality of thrusters including at least one thruster on each wing of said pair of wings, wherein said plurality of thrusters provides sustained rotation of the pair of wings in said rotary-wing-mode VTOL flight and sustained forward motion of the pair of wings and of the entire aircraft in said non-rotary forward airplane-mode flight,

wherein said at least one thruster on a first one of said pair of wings is able to thrust in substantially an opposite direction from propulsion from said at least one thruster on a second one of said pair of wings in said rotary-wing-mode VTOL flight and,

wherein said propulsion from said at least one thruster on said first one of said pair of wings is able to thrust in substantially a same direction as propulsion from said at least one thruster on said second one of said pair of wings in said non-rotary forward airplane-mode flight, and

wherein, in a transition between said rotary-wing-mode VTOL flight and said non-rotary forward airplane-mode flight, said at least one thruster on said first one of said pair of wings is affixed to said first one of said pair of wings and rotates in a feathering rotation with said first one of said pair of wings about a pitch change axis of said first one of said pair of wings, said pitch change axis being substantially parallel to a span of said first one of said pair of wings, and where said at least one thruster and said first one of said pair of wings rotate in said feathering rotation through an angle change exceeding about 120 degrees relative to the hub.

27. The aircraft of Claim 26, wherein each of said plurality of thrusters is an unshrouded propeller.

28. The aircraft of Claim 26, wherein each of said plurality of thrusters is a shrouded turbine.
29. The aircraft of Claim 26, wherein propulsion from each of said plurality of thrusters is varied differentially in said non-rotary forward airplane-mode flight to control yaw rotations of said aircraft.