Small V/STOL Optionally Manned UAV
for Personnel Recovery / Medical Evacuation

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Outline

1. Conventional V/STOL Aircraft
   Some Traditional Solutions and Challenges
   Shafts, Gears, Transmissions: the Enemies of V/STOL

2. V/STOL Aircraft: A New Paradigm
   Finding the ‘Knee of the Curve’: The Optimum System, Challenges

3. AVX Fans and Lift/Thrust Systems
   50:1 Bypass, 25:1 Thrust/Weight, Low Noise, Low InfraRed Emissions

4. Optionally Manned UAV / AVX-12 PAV
   for Personnel Recovery / Medical Evacuation
V/STOL Aircraft with Turbojets / Low-Bypass Fans

Compact Lift System Offers High-Speed Potential, But
High Jet Velocity Raises Dust Clouds, Causes Thundering Noise
High Fuel Consumption Limits Range / Endurance.
Transonic Exhaust has Greater Louver Losses,
High Fuel Consumption Limits Range / Endurance.
Lockheed F-35

Much Better than a Harrier

But Optimized for Transonic Operation
Helicopters

Look Good on a Golf Course

But,

Transonic Tips are Noisy, Rotors Beat Up Quite a Storm, There is Danger from Wires, Trees, Buildings, Cannot be Operated in Urban Areas.
V-22 Tilt-Rotor

First Flight (XV-3) : 1955
IOC : 2007 (52 years later!)

Speed and Range are Better than Helicopters,

But,

Greater Space Claim,
Danger from Wires / Trees / Buildings,
Cannot be Operated in Urban Areas,
Complex, Heavy Transmission System.
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Shaft, Clutches & Gears: The Enemy of V/STOL

Helicopters are weighed down by complex transmissions for main rotor and tail rotor.

CH-53E Needs 44 Hours of Maintenance per Flight Hour.
Shaft, Clutches & Gears : The Enemy of V/STOL

Gear Boxes (2)
Reduce Speed, Turn Output

Gear Box
Reduces Speed, Divides Output

Power
Transfer Shafts (2)

Swivel Drives for Gear Box and Engine

“Simple, Reliable System”? Not!

Fully Articulated Rotors (Collective + Cyclic)

Prop Drive Systems (2)
Helicopters, Tilt-Rotors and the Next V/STOL Aircraft

Mechanical Geared Pendulum Watches Served Us Well, But Have Been Replaced by More Accurate, Less Expensive Quartz Watches.

Slow, Smelly Horse-Carriages Served Us Well, But Have Been Replaced by Faster, Easier to Drive, Less Expensive Automobiles.

Helicopters Too Have Served Us Well, But Are Technologies Now Feasible to Replace the Helicopter?
Boeing Dragonfly Canard Rotor/Wing (CRW)

Helicopter in a Box? : The Bell / Urban Aero. X-Hawk

V/STOL Aircraft: noun. definition:
A Flock of Gear Boxes in Close Formation Flight, Tied Together by Shafts?
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Reduced Disk Loading Offers Greater Lift Capacity

Empirical Data
Lift / Power, lb/hp = 25 / SQRT (Disk Loading, psf)

Theoretical Limit
Lift / Power, lb/hp = 53.3 / SQRT (Disk Loading, psf)

Lift Jets
Lift Fans
Tilt-Rotors
Helicopters
Disk Loading vs. Power Loading: Ducted Fans are Better

Theoretical Limit

Empirical Successes

CH-47

X-22A

Doak

Tilt-Rotors, Tilt-Wings, Vert. Props

Well-Designed Ducts of Optimum h/D

Helicopters

Chrysler VZ-6, Lossy Duct

X-Hawk

JSF Fan

Harrier
It Is Possible to Have Low Power Needs, Compact Dimensions

Power, hp, per 1000 lbs VTOW

Disk Area, sq. ft., per 1000 lbs VTOW

- **Lift Jets**
  - Powerful Engines
  - High Engine Weight
  - High Fuel Weight
  - High Jet Noise

- **AVX Fans**
  - Optimum Disk Loading
  - No Shafts, Clutches, Gears

- **Tilt-Rotors**
  - Large Size
  - High Rotor Weight
  - High Driveline Weight
  - High Blade-Tip Noise

- **HARRIER**
  - Low Bypass
  - Lift Fans

- **JSF Fan**
  - Lift Fans

- **Helicopters**
  - Turbine

- **Piston**

- **Magic Pill**

- **CH-K-MAX**
Challenges to Achieving the Optimum Disk Loading:
Conventional Turbo-Fans Are Limited to Moderate Bypass Ratios
by the Need for Gears

Engines Have Become Lighter, More Compact
Over Time,
Gear-Boxes have Not Changed as Much.
AVX Fans: Scalable Lift / Thrust Systems
Ideal for V/STOL, Air Cushion and Surface Effect Vehicles

AVX Fan in Duct
50:1 By-Pass Ratio
Super-High Fuel Efficiency
Very Low Noise ($\Delta_{\text{JetNoise}} = -35 \text{ dB}$)
25:1 Thrust/Weight Ratio
Very Light Weight
No Infra-Red Emissions
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The AVX Fan™ System
Eliminates Shafts and Gears, Saves Weight.

Hot Gases from a Core Engine
Are Effluxed through
Slots on Upper Surface of Fan Blades,
Nozzles on Blade Tips.

Fan Blades are Driven by Jet Reaction,
Have high CL by Slot Blowing.
Can have low Speed, Low Weight, Low Noise.

AVX Fans
are Immune to Stalling,
Can Tolerate
Distorted Inlet Flow.
Geared Fans vs. AVX Fans

Conventional Fan Drive

- Power turbine
- Multi-Stage Reduction Gears
- Geared Fan

D-STAR Fan Drive

- Direct-drive fan

Turbo-Jet Core
D-STAR / Aurayan AVX Fan™ Conceptual Design

Inertia Ring and Foil-Air Bearings
The AVX Fan™ System in Duct with Coanda Slots
The D-STAR AVX Fan™ Lift / Thrust System

Engine and Fan are Angled in Duct

Duct has NACA Inlet, Blown Coanda Slot for High-Speed Flow Capture

Duct Exit has Louvers in Belly, Flap in Thrust Nozzle.
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Optionally Manned UAV / AVX-12 PAV
for Personnel Recovery / Medical Evacuation

Carry 4 in a C-130, Self Loading / Unloading

Max. Speed 260 knots

Range 440 nmiles with 700 lbs., VTO

Range 820 nmiles with 500 lbs, U-STO
Optionally Manned UAV / AVX-12 PAV for Personnel Recovery / Medical Evacuation

- Mini-ISO Container (MISO Pack) 84” x 28” x 24”
- LSTAT / CSTAT Supplies
- Alternative MISO Packs
- Spinning Dust Separator
- Boom Tail Retracted for Transportation, Parking
Optionally Manned UAV / AVX-12 PAV
for Personnel Recovery / Medical Evacuation

- Boom Tail Extended for Flight
- LSTAT / CSTAT
- Medical Supplies
Optionally Manned UAV / AVX-12 PAV
for Personnel Recovery / Medical Evacuation

- Thrusting + Lifting Louvers
- Opposable Pairs of Louver Sets Provide 6-D.O.F. Control
- Single Turbofan Engine, with High Reliability (No Gears, No Shaft, Oil-Free Lubrication)
- Inlet Vanes w/ BLC
- Coanda Slots for Flow Turning
- AVX Fan
- BRS Chute
- Lifting Louvers
- Pneumatic Telescopic Tail Boom
- Air Duct
- 18 deg.
Optionally Manned UAV / AVX-12 PAV
for Personnel Recovery / Medical Evacuation

AVX-12 : Preliminary Analysis

Weights : Empty : 600 lbs, Max. Payload : 700 lbs; Fuel : 700 lbs;
VTOW : 2000 lbs

Dimensions : Body : 12 ft. 3” L, 7 ft W.

Power : Core Gas Generator (no fan or output shaft)
from a 800 hp class turbine engine.

Loadings : Fan Disk : 100 psf; Fan Power : 2.5 lbs/hp; Planform Area : 25 psf

Preliminary Performance Projections

Max. Speed : 260 knots

Range : 440 nmiles with 700 lbs., VTO
820 nmiles with 500 lbs, U-STO
Optionally Manned UAV / AVX-12 PAV
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AVX-12 : Range at Mid-Cruise Weight
VTO (@2000 lbs), Normal Payload (500 lbs)

Maximum Range
Conclusions

1. It is Time for Complex, Costly, Cumbersome Clap-Trap Contraptions Called Helicopters to be Replaced by Compact, Quiet, Lower Cost Air Vehicles.

2. The Trade-Off between Power and Rotor Size Leads to an Optimum $\approx 100$ psf Disk Loading, $10$ lbs/hp Power Loading.

   But, this Optimum must be Achieved without Heavy, Maintenance-Prone Shafts & Gears.

3. The AVX-12 PAV / UAV by D-STAR / AurAayan Offers Low Cost & Low Complexity Safe and Quiet Operation Ability to Operate in Urban / Forested Areas Excellent Speed, Range and Endurance.