16.00 Introduction to Aerospace and Design
LTA Vehicle Engineering

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Objectives

- Enable 16.00 students to reliably engineer and operate their LTAs
- Introduce students to fundamentals of the radio control and electric propulsion equipment
- Brief important installation and operations information
Purposes of LTA Propulsion and Electronics Systems

• Thrust for forward flight
  – Large vs. small motors?
  – Controllable motor(s) speeds
• Control of flight path
  – Gentle ascents and descents
  – Turning maneuvers
  – Options: swiveling motors vs. propeller
    “blast” over control surfaces
- Not recommended: airplane-like control surfaces requiring forward speed for effectiveness
Summary of equipment provided

- Digital proportional r/c equipment
  - 4 function transmitter and receiver
  - Servos – motorized actuators
  - Receiver battery – 4.8V, 500 mah
  - Overnight charger, On/off switch harness
- Electric propulsion
  - 2 sizes of electric motors
  - Electronic Speed Controls (ESC)
  - Rechargeable motor battery – 9.6V, 600 mah
  - Propellers – various sizes
4 channel transmitter - features

- 2 control sticks @ dual axis (4 control axes)
  - 3 axes are spring loaded to neutral center
  - 1 axis (left stick, vertical) “ratchets”, holds position
- Mechanical trims – used to adjust neutral position
- Power indicator – tells charge state, NOT charge remaining
  - Turn transmitter off when not in use; or when charging
  - Overnight charging required prior to long term use
Transmitter features, continued

- **Mechanical reversing switches**
  - Use to reverse rotation of servos

- **Frequency crystal with channel #**
  - Transmitter crystal channel # must match receiver crystal
  - Do not remove crystals from receivers and transmitters – come see us if your radio isn’t functioning properly!
4 channel receiver - features

- 1 meter wire antenna – may be folded over, do not cut!
- 1 input port (battery), 4 output ports (servos, ESCs)
- Each port has a three pin interface (unmarked)
  - **VERY IMPORTANT:** Connectors’ wiring sequence, left to right
  - Signal (white) – power (red) – ground (black)
  - Damage will occur if sequence is not maintained!
  - Maintain proper sequence when fab’ing extension wires!
- **Connectors have preferred orientation for insertion** (metal tabs facing to receiver top edge) - do not force as connectors are keyed
Receiver features, continued

- Receiver battery pack: 500 mah 4.8 volt rechargeable battery
  - Must be overnight charged for full capacity
- On/off harness
  - For extra assurance, physically disconnect battery rather than risk misreading on/off switch (when not using equipment)
Servo motors - features

- Used to actuate aero surfaces or rotate electric motors
  - Closed loop control, position and velocity feedback
- Rotary shaft output: +/- 60 degrees
  - 4 armed “star” or circular wheel
  - Normally installed orthogonal to servo case @ neutral
- Due to LTA geometries, wiring extensions will be needed
  - Color coded extension wires will be provided
  - Solder all connections and use shrink tubing to insulate connections
Servo motors – installation

- Best: small wood screws into wooden supports
- Options: double sided foam tape + 1 drop c/a (superglue); velcro; tape; nylon tie-wraps
Electronic speed controls (ESCs)

- Allows proportional speed control of electric motors
- Electrical connections
  - Connector into receiver
  - Solder to back of electric motor
  - Connector to motor battery
- Uni-directional thrust only, reverse thrust not available!
ESCs, continued

- Microprocessor controlled
  - Senses for “low throttle” input to activate; motors should not operate until the control stick is first moved to the “off” position
  - If intermittent signals detected – ESC shuts down
    - Solder all connections!
- ESC normally controlled by “ratchet” axis, low to high positions
  - If an ESC is controlled by another control axis: center position = partial throttle, not “off”
- If electric motor runs in the wrong direction: switch the leads to the back of the motor
- **When checking out the power system for the first time, please remove the propeller(s)**
R/C equipment, hints and tips

• Pre-plan desired control functions versus 4 control axis controls –
  – Human Factors Engineering is important!
• Don’t modify the transmitter control stick centering springs!
• Observe the wiring convention (signal/white, power/red, ground/black) at all times
• Complete electrical and propulsion end-to-end functional tests as soon as possible
  – Check for defective components, wiring errors, intermittent interference (induced by motors), verify proper control surface movement, etc.
Linkages

- Connects servos to control surfaces and motor mounts
- Choices:
  - Wire-in-rod or tube-in-rod linkages
  - Balsa or dowel rods with wire fittings
  - Thread or monofilament “pull-pull”
  - Steel “music wire” – 1/16” - 3/32” OD
Mechanical Clevises

- Brass or plastic turnbuckles with machined threads, connects linkages to control horns
- Attaches to wire linkage ends
- Allows fine adjustment of control linkage length
Control horns

- Attaches to control surface, provides connection to servo linkage
- Choices:
  - Commercial plastic control horns
  - Thin plywood, aluminum, or nylon
  - Nylon or metal screws with suitable fittings.
Frequently Asked Question:
How can control surface deflection be increased?

- Use outermost hole at servo arm
- Use innermost hole at surface’s control horn
Hinges

- **Choices**
  - 3 ply “c/a hinge paper”
  - Pressure sensitive tape (clear tape is best)
- **Important installation hint:**
  - Be sure control surface is rounded/bevelled so surface can rotate smoothly without mechanical binding
  - Strive for minimum gaps between control surface and fixed stabilizer sections
Final hints and tips

• If something doesn’t work, don’t take it apart!
  – Bring it in and we’ll diagnose problems, replace what’s necessary
• Solder all connections and observe wiring convention
Hints and tips - adhesives

- C/A (superglue) best when joining large surface areas; not good when wood end-grain is involved (C/A “wicks up” the wood by capillary action)
  - C/A bonds are inherently brittle and ‘glassy’
- Wood glue (Elmer’s Carpenter glue) is good for strong, flexible joints
  - Use tight fitting joints and clamping/pinning
- 2 part ‘5 minute’ epoxy – strong, fills gaps, but is heavy
- Wrapping wooden joints with cotton thread – strengthens joints considerably, low weight gains
- Use supplied wax paper to prevent gluing work to tables
Final hints and tips

- Return all tools, supplies, adhesives, etc. when done using
- Maintain a tidy workspace – please clean up!
- Respect others’ vehicles and property: don’t damage other LTAs, don’t borrow equipment without permission
- Work as a team and have fun!