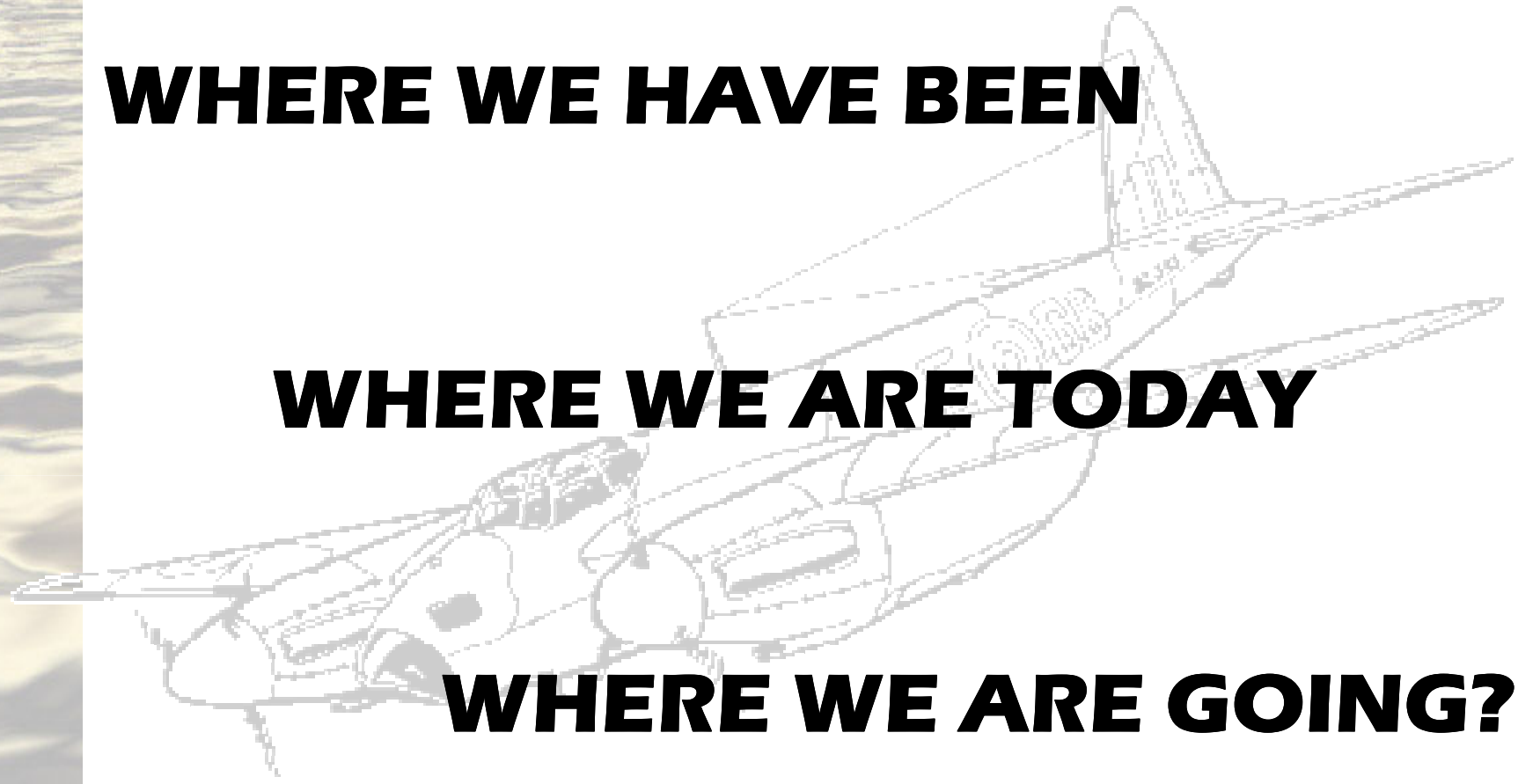
GETTING STARTED IN ELECTRIC FLIGHT

Tom Hunt Cradle of Aviation Model Show 2008



WHERE WE HAVE BEEN

WHERE WE ARE TODAY

WHERE WE ARE GOING?

WHERE WE HAVE BEEN

UNDERPOWERED, OVERWEIGHT MODELS

- **POOR MOTOR EFFICIENCY**
  (INEXPENSIVE BRUSH MOTORS/MABUCHI)

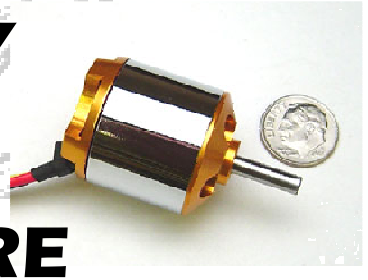
- **INEFFICIENT AIRCRAFT STRUCTURE**
  (OVERDESIGNED ARF MODELS USUALLY
  WITH TOO MUCH PLYWOOD AND HEAVY PLASTIC)

- **HEAVY BATTERIES**
  (NICD CHEMISTRY BATTERIES ALL THAT WE HAD)

WHERE WE ARE TODAY

"IMPRESSIVELY POWERED LIGHT WEIGHT MODELS

- **EXCELLENT MOTOR EFFICIENCY**
  (INEXPENSIVE BRUSHLESS MOTORS)



- **EFFICIENT AIRCRAFT STRUCTURE**
  (LASER CUT ARFS AND KITS WITH ALL THE "FAT" TAKEN OUT, LIBERAL USE OF FOAM PARTS)

- **MUCH LIGHTER BATTERIES**
  (LI-ION AND LI-POLY CHEMISTRY WITH 2 - 3 TIMES THE ENERGY DENSITY OF NIMH AND 4 – 6 TIMES THE ENERGY DENSITY OF NICD)

WHERE WE ARE GOING?

- **CHEAPER HOBBY?**

  AS THE MARKET GROWS FOR E-POWERED MODELS AND ASSESORIES, THE PRICES WILL DROP.

- **EVEN LARGER MODELS?**

  THOUGH 1/5 AND EVEN SOME ¼ SCALE WARBIRDS HAVE BEEN FLOWN WITH E-POWER, THE COST IS CURRENTLY PROHIBITIVE FOR THE SPORT MODELER.

- **EVEN BETTER BATTERIES?**

  BATTERY TECHNOLOGY IMPROVES DAILY, BUT WILL WE MOVE TO MINIATURE FUEL CELLS AND RUN OUR MODELS ON WATER?

TOOLS OF THE TRADE

- **AMMETER OR WATTMETER?**

  A SIMPLE AMMETER (TO MEASURE CURRENT) IS A MUST HAVE TOOL IN THE FIELD BOX/SHOP, BUT A WATT METER IS BETTER STILL. A WATT METER WILL NOT ONLY TELL YOU THE CURRENT IN THE SYSTEM, BUT THE POWER (WATTS), BATTERY VOLTAGE AND USED CAPACITY OF THE BATTERY

ASTROFLIGHT
"WHATMETER"

A WATT METER WILL TELL YOU:

- **YOU'RE TRYING TO FLY A CAR (TOO LITTLE POWER)**
- **YOU'RE ABOUT TO "SMOKE" THAT ESC OR MOTOR (TOO MUCH CURRENT).**
- **YOU MADE THE RIGHT DECISION ON PROP CHOICE**

TOOLS OF THE TRADE

- **TACHOMETER**

  HAVING RPM DATA ON A PARTICULAR PROPELLER, COMBINED WITH THE DATA FROM YOUR WATT METER WILL HELP YOU MAKE AN "EDUCATED" DECISION ON WHETHER YOU MADE THE RIGHT CHOICE OR THAT YOU ARE AT LEAST GOING IN THE RIGHT DIRECTION.

TOOLS OF THE TRADE

- **SOLDERING IRON**

  IF YOU ARE AT ALL INTERESTED IN ELECTRIC AIRCRAFT MODELING, YOU WILL NEED A GOOD SOLDERING IRON. LOOK FOR ONE WITH AN ADJUSTABLE TEMPERATURE AND REPLACEABLE TIPS.

A BAD SOLDER JOINT IN A CONNECTOR, BATTERY OR MOTOR CAN CAUSE A LOSS OF POWER AND/OR A CRASH! TAKE THE TIME TO LEARN HOW TO USE IT PROPERLY!

ENTERING E-FLIGHT TURN-KEY SYSTEMS

A TURN-KEY IS SYSTEM IS ONE THAT IS COMPLETELY PUT TOGETHER FOR YOU BY A MANUFACTURER/DISTIRBUTER.

WE TRUST THAT THEY HAVE DONE A GOOD JOB AT ENGINEERING THE ENTIRE SYSTEM (FROM BATTERY TO PROP AND EVERYTHING IN BETWEEN) BUT OFTEN I FIND THAT THEY CHOOSE COMPONENTS BASED ON THE $$$$ AND NOT SOUND ENGINEERING PRACTICES.

ENTERING E-FLIGHT TURN-KEY SYSTEMS (RTF)

IN THE PAST MODELS DESIGNED FROM THE START AS ELECTRIC MODELS HAD MUCH BETTER SUCCESS AT PERFORMING WELL THAN CONVERTING MODELS DESIGNED FOR GLOW POWERED.

TODAY, MANY MODELS ARE DESIGNED FOR EITHER POWER SYSTEM AND WITH PROPERLY CHOSEN COMPONENTS FOR THE ELECTRIC POWERED MODEL CAN ACTUALLY OUT PERFORM THE GLOW POWERED MODEL.

TURN-KEY SYSTEMS WHAT TO LOOK FOR

THOUGH MANY MODELS BELOW 2 LBS ARE HARD TO GET WRONG (BECAUSE OF THE RELATIVELY LOW POWER REQUIRED TO FLY THEM), LARGER MODELS (40 GLOW SIZE AND LARGER) ARE OFTEN "WEAK" IN PROPER ENGINEERING.

ONE OFTEN FINDS THEM ENGINEERED WITH TOO SMALL A MOTOR, TOO SMALL A PROP,TO AND/OR FEW CELLS.

THESE MODELS ARE NOT USUALLY UNDERPOWERED. TO GET THE POWER THEY NEED TO FLY WELL, THEY PRACTICE A POOR METHOD OF USING TOO FEW CELLS AND PUMPING UP THE CURRENT!
WATTS (POWER) = VOLTS X AMPS(CURRENT)!

HIGH CURRENT MEANS HIGH HEAT AND SHORT OR LONG TERM DAMAGE TO E-POWER COMPONENTS!

TURN-KEY SYSTEMS GETTING A GOOD START

HORIZON HOBBIES THROUGH THEIR EFLITE AND PARKZONE BRANDS OF MODELS AND COMPONENTS IS A LEADER IN RTF AND ARF ELECTRIC MODEL SYSTEMS.

FOR BEGINNERS:

FIREBIRD: MOTOR, RUDDER, ELEVATOR $59.99 COMPLETE

FREEDOM: BIGGER MODEL, BETTER RADIO MOTOR, RUDDER, ELEVATOR $139.99 COMPLETE

PICTURES COURTESY OF HORIZON HOBBY WEBSITE

TURN-KEY SYSTEMS GETTING A GOOD START

FOR THE NEXT STEP (NOVICE):

J-3 CUB: BRUSHLESS MOTOR/LIPO BATTERY, RUDDER, ELEVATOR $159.99 COMPLETE

MULTIPLEX EASYSTAR: BIGGER MODEL, BETTER RADIO, BRUSH MOTOR/NIMH BATTERY, RUDDER, ELEVATOR $194.99 COMPLETE

PICTURES COURTESY OF HORIZON HOBBY WEBSITE

TURN-KEY SYSTEMS GETTING A GOOD START

FOR THE NEXT STEP (INTERMEDIATE/ADVANCED):

T-26 TROJAN: BRUSHLESS MOTOR/LIPO BATTERY, MOTOR, AILERON, RUDDER, ELEVATOR $219.99 COMPLETE

PICTURE COURTESY OF HORIZON HOBBY WEBSITE

TURN-KEY SYSTEMS GETTING A GOOD START

FOR THE NEXT STEP (ADVANCED):

EVERYONE LOVES A WARBIRD!
EVERYONE LOVES THE MUSTANG!

ALSO AVAILABLE:
SPITFIRE
FW-190

P-51 MUSTANG: BRUSH GEARED MOTOR/NIMH BATTERY, MOTOR, AILERON, RUDDER, ELEVATOR $179.99 COMPLETE

PICTURE COURTESY OF HORIZON HOBBY WEBSITE

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TURN-KEY SYSTEMS *LEARN FROM THEM!*

IF YOU WANT TO MOVE ON TO MODELS THAT ARE NOT AVAILABLE IN RTF VERSIONS, WE NEED TO LEARN FROM THE MODELS WE HAVE AND "EXTRAPOLATE" OR CARRY THAT KNOWLEDGE TO THE NEXT MODEL.

LEARN FROM YOUR TURN-KEY MODELS!

WE MUST:

- **MEASURE THE WATTAGE IN THE SYSTEM.**
- **WEIGH THE MODEL**
  - **SO WE CAN COMPUTE POWER LOADING (WATTS/LB)**
- **MEASURE THE RPM OF THE PROP**
  - **WE CAN ESTIMATE THE FLYING SPEED KNOWING PITCH AND RPM**
- **COMPUTE OR LOOK-UP THE WING AREA**
  - **SO WE CAN COMPUTE WING LOADING (SKILL LEVEL INDICATION)**

ENTERING E-FLIGHT – STARTING FROM NOTHING

WE GENERAL CLASSIFY THE ELECTRIC POWER REQUIRED TO FLY A MODEL AS *WATTS/LB*, JUST AS A GLOW OR GAS MODEL USES *CUBIC INCH* DISPLACEMENT (SUCH AS AN "049" OR a "40".)

NOTE TO AUDIENCE!

NO ONE ON THIS EARTH CAN EQUATE A MOTOR TO A CUBIC INCH DISPLACEMENT!

DYI POWER SYSTEMS - MOTORS

POWER, CONVERTED TO THRUST FLIES AIRCRAFT!

POWER FROM ELECTICITY IS CALLED *WATTS*

746 WATTS = 1 HP (ABOUT THE POWER OF A PLAIN-JANE 40 GLOW ENGINE.)

ELECTRIC MOTORS DO NOT HAVE A "FIXED" OPERATING RANGE!

ONE CAN RUN A MOTOR EFFICIENTLY AT 500 WATTS AS WELL AS 1000 WATTS! A GLOW 40 ENGINE HAS A VERY NARROW OPERATING RANGE . MISUSE A GLOW ENGINE AND THE MODEL EITHER DOES NOT FLY, OR THE ENGINE OVERHEATS AND CAUSES DAMAGE TO YOUR INVESTMENT.

ELECTRIC MOTORS HAVE A VERY BROAD OPERATING RANGE AND THUS CAN BE MUCH MORE COST-EFFECTIVE TO THE MODELER.

SIMPLY STATED..... **BIG MODELS - BIG MOTORS!**
SMALL MODELS - SMALL MOTORS!
HIGH Kv MOTORS – SMALL PROPS – GO FASTER
LOW Kv MOTORS- BIG PROPS – GO SLOWER

DYI POWER SYSTEMS - BATTERIES

POWER MUST BE EXTRACTED FROM THE BATTERY TO TURN THE MOTOR.

A POORLY CHOSEN BATTERY FOR THE TASK WILL PROBABLY OVERHEAT AND BE RUINED IN A SHORT TIME.

DO NOT BELIEVE THE MANUFACTURES RATED DISCHARGE CAPACITY, USE 50-70% OF THEIR NUMBER FOR GOOD BATTERY LIFE.

SIMPLY STATED.....BIG MODELS - BIG BATTERIES,
SMALL MODELS - SMALL BATTERIES.

ENTERING E-FLIGHT – STARTING FROM NOTHING

WATTS/LB OF TYPICAL MODELS USING BRUSHLESS* MOTORS:

*USE VALUES ABOUT 20-30% HIGHER FOR INEXPENSIVE BRUSH MOTOR SYSTEMS

•TRAINER	40-50
•SPORT	50-60
•SPORT AEROBATIC	60-80
•AGGRESSIVE AEROBATIC	80-100
•SCALE	50 -100
•3D	100+
•DUCTED FANS	100+

ENTERING E-FLIGHT – STARTING FROM NOTHING

Estimate weight of model

- **Li-poly battery……. same or only slightly more than glow weight**
- **NiCd/NiMh…. ½ lb more for 20-30 glow, 1 lb more for 40 glow, 2 lbs more for 60 glow**

Compute watts required

- **Power loading (Watts/lb) X weight (lbs)**

Compute voltage

- **Watts ÷ 20 amps (.15-.25 glow)**
- **Watts ÷ 30 amps (.30-.60 glow)**
- **Watts ÷ 40 amps (.90-1.20 glow)**

ENTERING E-FLIGHT – STARTING FROM NOTHING

Determine battery needs

- **Use 1.0 v/cell for NiCd/NiMh chemistry up to 40 amps**
- **Use 3.7 v/cell for li-poly chemistry up to 20 amps**
- **Use 3.5 v/cell for li-poly chemistry up to 40 amps.**

EXAMPLE:
WATTAGE = 300
CURRENT = 30 AMPS
VOLTAGE = 10 (W/A)
 # CELLS

- **NICAD/NIMH =10**
- **Li-poly = 2.7 (use 3)**

ENTERING E-FLIGHT – STARTING FROM NOTHING

CHOOSE PROPELLER - (PITCH/DIAMETER (P/D) RATIO)

A 12 X 6 PROP HAS A P/D RATIO OF .5

A 14 X 10 PROP HAS A P/D RATIO OF .71

- TRAINER (.4-.6)
- SPORT (.5-.7)
- AEROBATIC (.6-.75)
- SCALE (DEPENDS ON DRAG)
  - WW1/GOLDEN AGE .4-.6
  - WW2 FIGHTER .6-.75
  - WW2 BOMBER .5-.6
- GENERAL AVIATION WW2-PRESENT (.5-.75)
- 3D (.4-.5)
- RACER (.9-1.2)

ENTERING E-FLIGHT – STARTING FROM NOTHING

All electric models with the exception of racing aircraft benefit from flying the biggest diameter prop possible.

Measure propeller clearance!

- **With model level, measure from centerline of prop shaft to ground.**
- **Subtract 1-1.5″ (depending on your flying surface)**
- **Multiply by 2 to get maximum diameter permissible.**
- **Multiply by P/D ratio to get pitch.**

ENTERING E-FLIGHT – STARTING FROM NOTHING

Now that we know:

Watts (based on style of flying and vehicle weight)

Voltage (number of cells)

Prop diameter and pitch (based on physical ground clearance constraints and type of flying)

Time to go pick out a motor!

Search though motor manufacturers for motor that will deliver the required watts (amps x volts) using the battery size (voltage), swinging the chosen prop.

ENTERING E-FLIGHT – TYPICAL MOTOR CHART

RimFire Out-Runner Brushless Motors 28 mm Diameter / 30 mm Length				
	28-30-750	28-30-950	28-30-1250	28-30-1450
Stock No.	GPMG4555	GPMG4560	GPMG4565	GPMG4570
Configuration 1	**28-30-750**	**28-30-950**	**28-30-1250**	**28-30-1450**
# of Cells	2	2	2	2
Prop Size	12x3.8SF	12x6SF	10x3.8SF	10x4.7SF
RPM	3870	4080	6600	6900
Current (A)	6.2	14.8	14.8	23.4
Configuration 2				
# of Cells	3	3	3	3
Prop Size	11x4.7SF	10x3.8SF	8x3.8SF	7x4SF
RPM	5610	7200	9660	13,550
Current (A)	10.5	15.1	15	17
Configuration 3				
# of Cells	4			
Prop Size	8x3.8SF			
RPM	9120			
Current (A)	8			

MODIFIED CHART COURTESY OF GREAT PLANES WEBSITE

THE END

GO!

FLY CLEAN!

FLY QUIET!

FLY AND CHARGE SAFELY!