Combat 101:

An Introduction to F2D Control Line Combat

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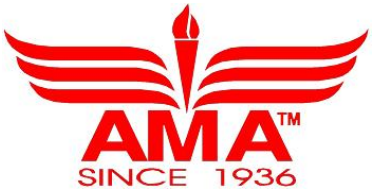
Verizon Labs – Waltham, MA

19 November 2003

Introduction

Who is this guy?

Name: Mark Rudner



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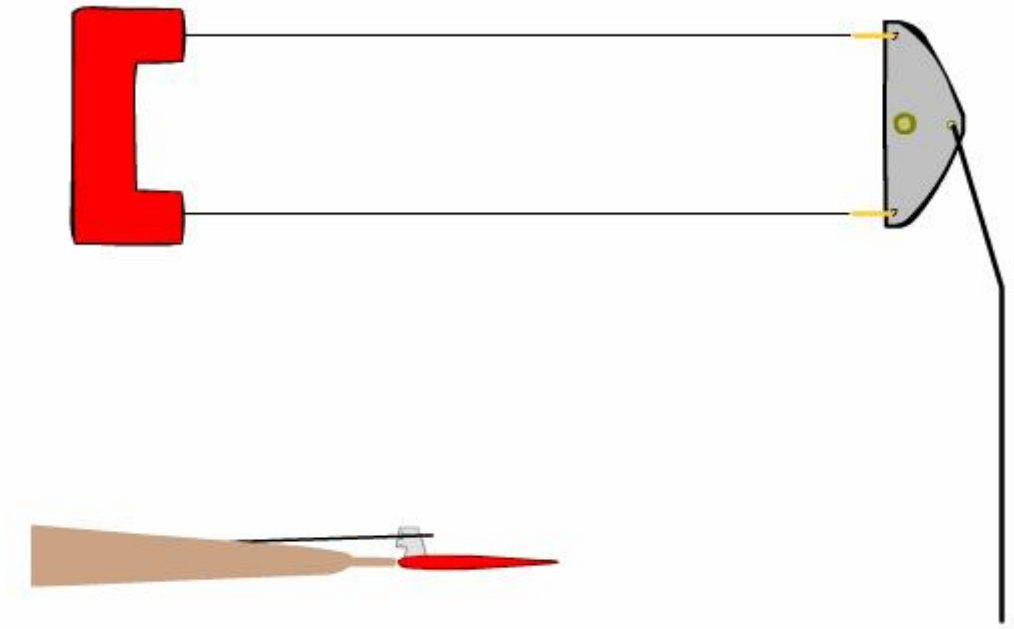
Introduction

The Basics of Control Line Flight



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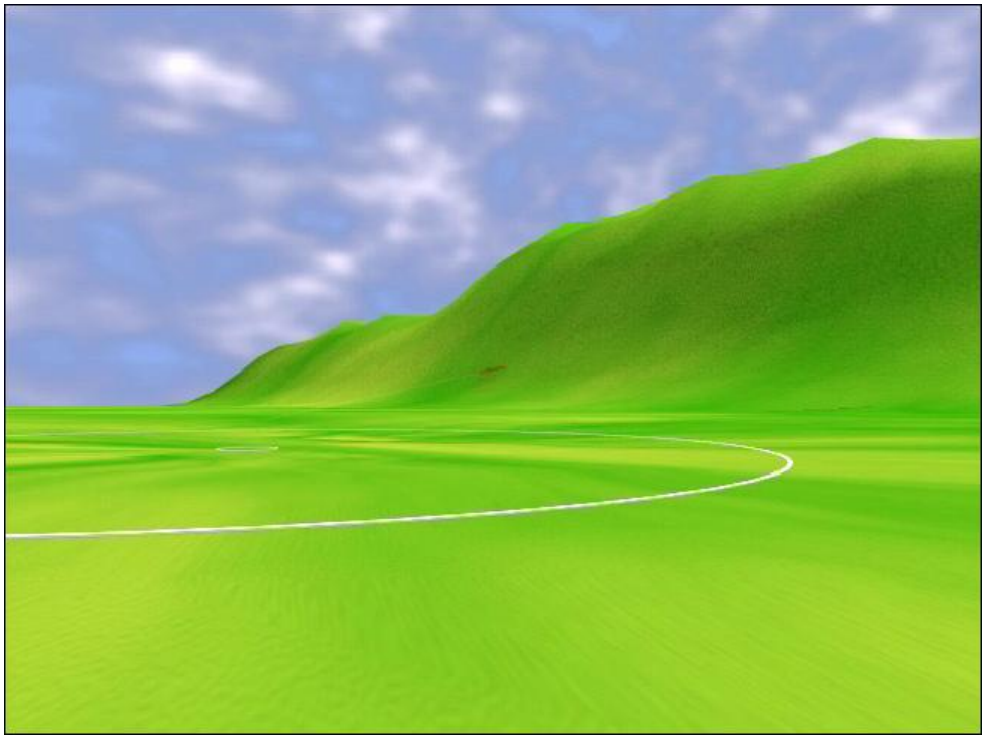
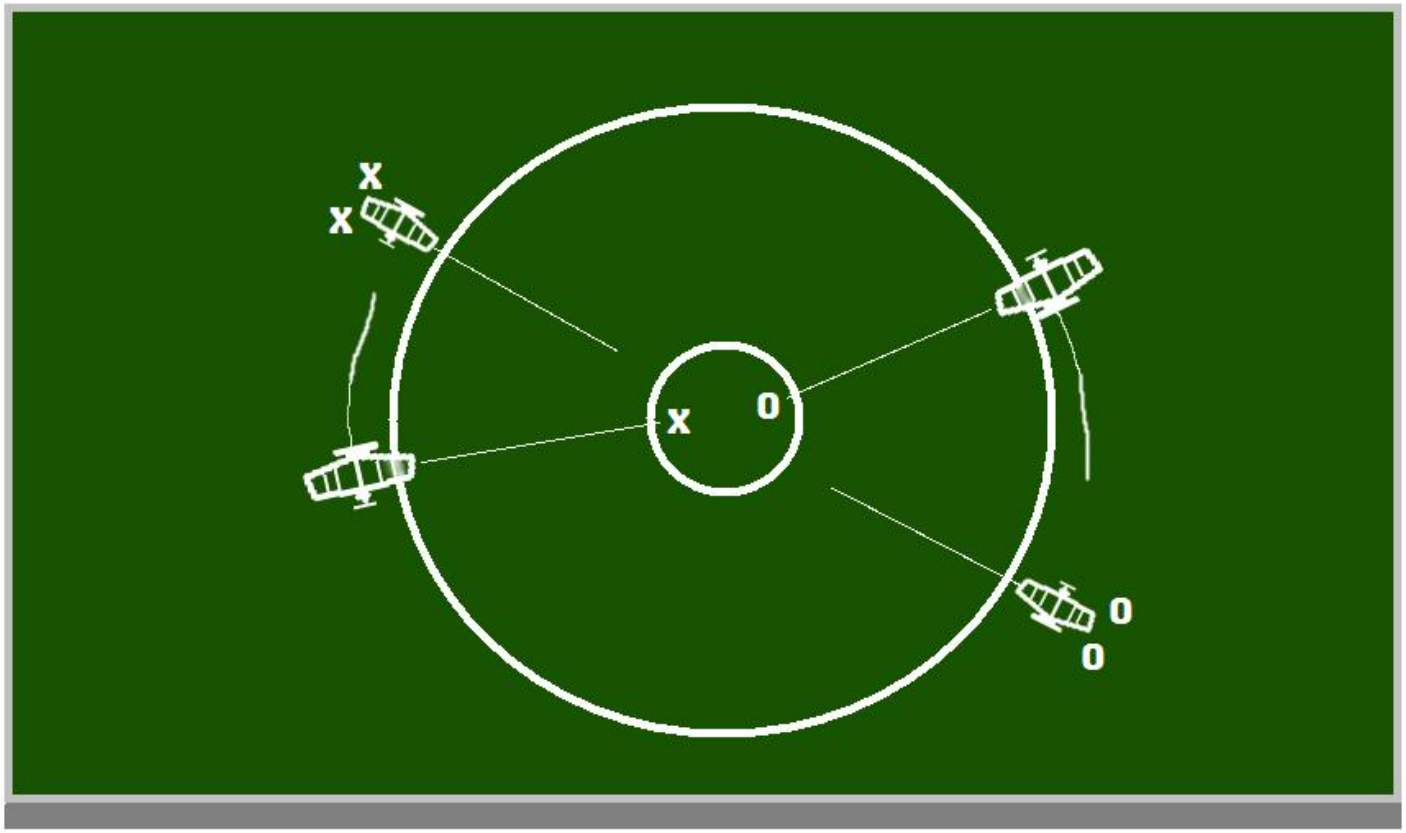
The Basics of Control Line Flight – An Animated Example



Control Line Combat

A “2D” Game of Cat and Mouse on the Topology of a Sphere



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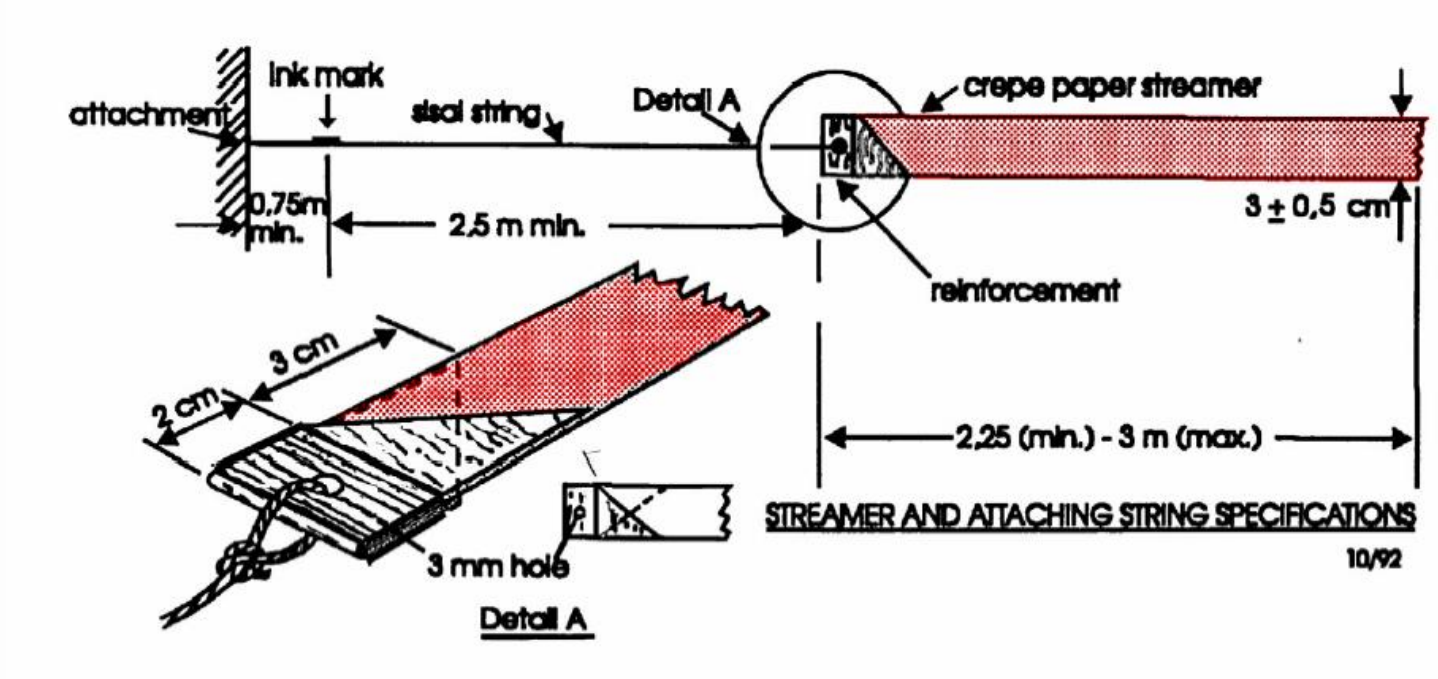

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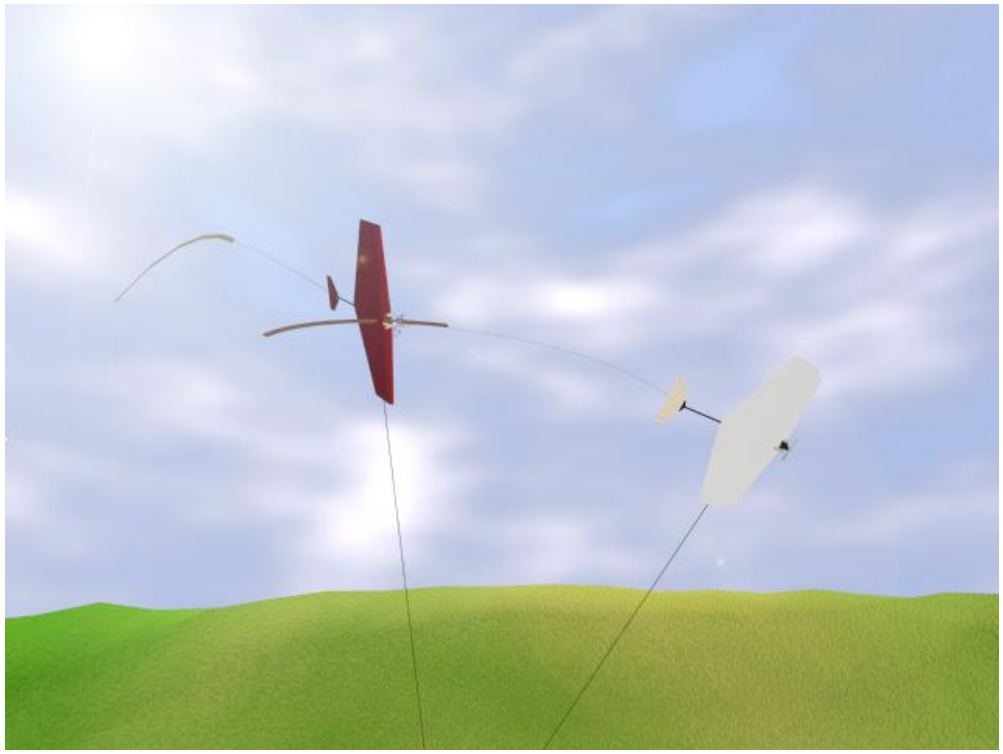

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Control Line Combat

A 2D Game of Cat and Mouse on the Topology of a Sphere

The Rules/Scoring

1 minute starting period, 4 minute match

100 pts for each cut on opponent's streamer

+1 pt for each second own model is airborne

-1 pt for each second own model not airborne

-40 pts for unintentionally leaving pilot's circle

Control Line Combat

Dogfight or Nouveau Ballet?

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The History of F2D

Champions of the World – Past and Present

1978 – Mick Tiernan (GBR) 

1980 – Oleg Doroshenko (USSR) 

1982 – Tom Fluker (USA) 

1984 – Loet Wakkerman (NED) 

1986 – Nikolai Necheukin (USSR) 

1988 – Boris Faisov (USSR) 

1990 – Vjacheslav Baliev (USSR) 

1992 – Vjacheslav Baliev (USSR) 

1994 – Mervyn Jones (GBR) 

1996 – Vjacheslav Baliev (RUS) 

1998 – Alexei Zhelezko (UKR) 

2000 – Stansilas Chornyy (UKR) 

2002 – Michael Willcox (USA) 

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The History of F2D

Understanding the (former) Soviet Domination

Aeromodelling was seen as in integral part of the military-industrial complex

Government support, school programs, and an organized training program led to the formation of a highly sophisticated infrastructure

The best of the best became full-time instructors, training the next generation of aeromodellers and aerospace industry bound young men and women

The History of F2D

Understanding the (former) Soviet Domination

Ekaterinburg (formerly Sverdlovsk), Russia

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The History of F2D

Understanding the (former) Soviet Domination

Ekaterinburg Championships, February 2001

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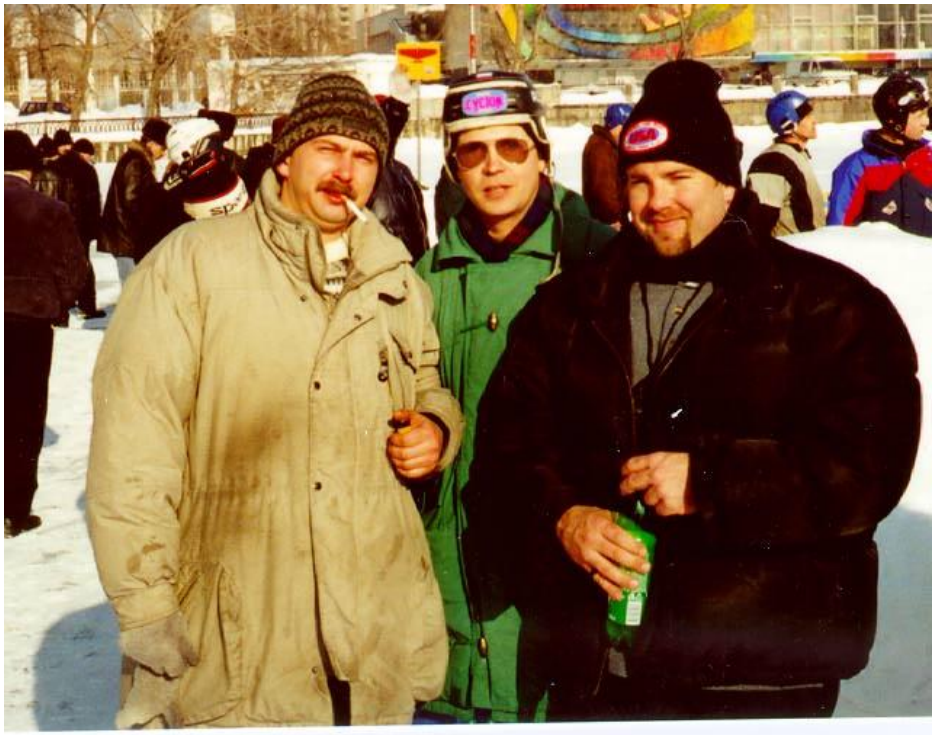

Ekaterinburg Championships, February 2001

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The History of F2D

Why “Russian” Engines Are So Good

Years of empirical modeling/testing, plus unlimited time/material resources for development

Special custom metallurgy and space-grade aluminum starting material for pistons, cases, etc.

Extremely meticulous and precise machining, ensuring that every part will fit just right at operating temperature

The History of F2D

Current Engine Specifications

2.5 cc maximum swept volume

1: **4 mm** maximum venturi diameter

2: **NO** sub-piston induction

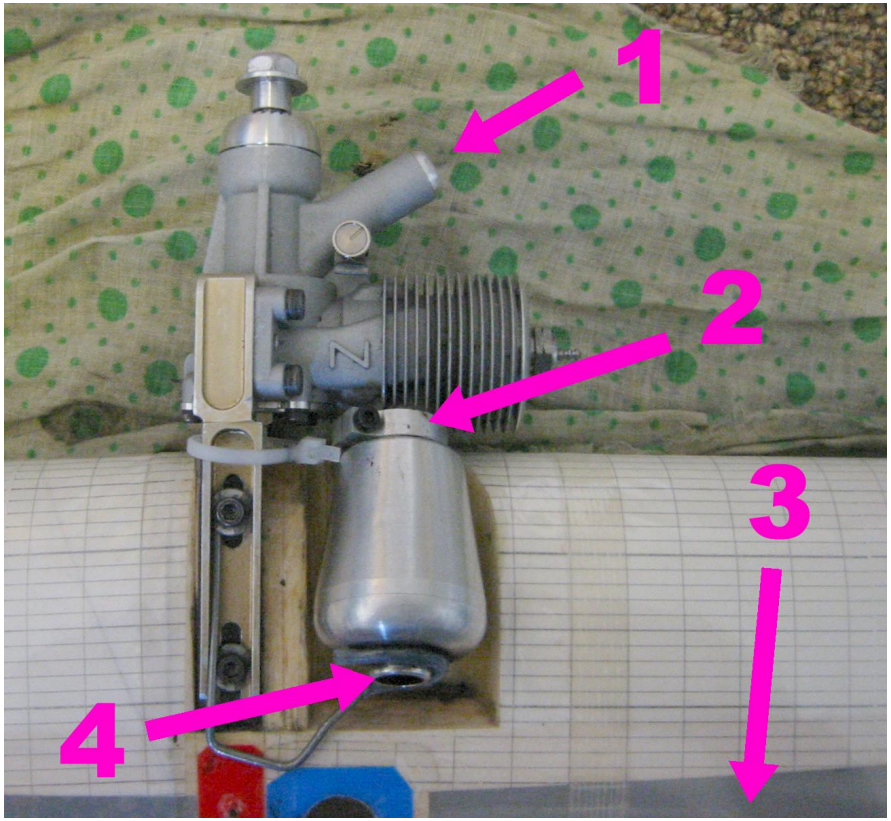
3: Contest-supplied fuel mixture

10% Nitromethane

20% Castor Oil

70% Methanol

4: Mandatory silencer with **8mm** maximum outlet diameter



The Equipment of F2D

Models

Typical Design

"Baseball Bat" leading edge

Adjustable aluminum beam mounts

Balsa ribs and spruce trailing edge

Hollow bladder compartment

Tough Mylar film covering

Steamer hook/muffler retainer

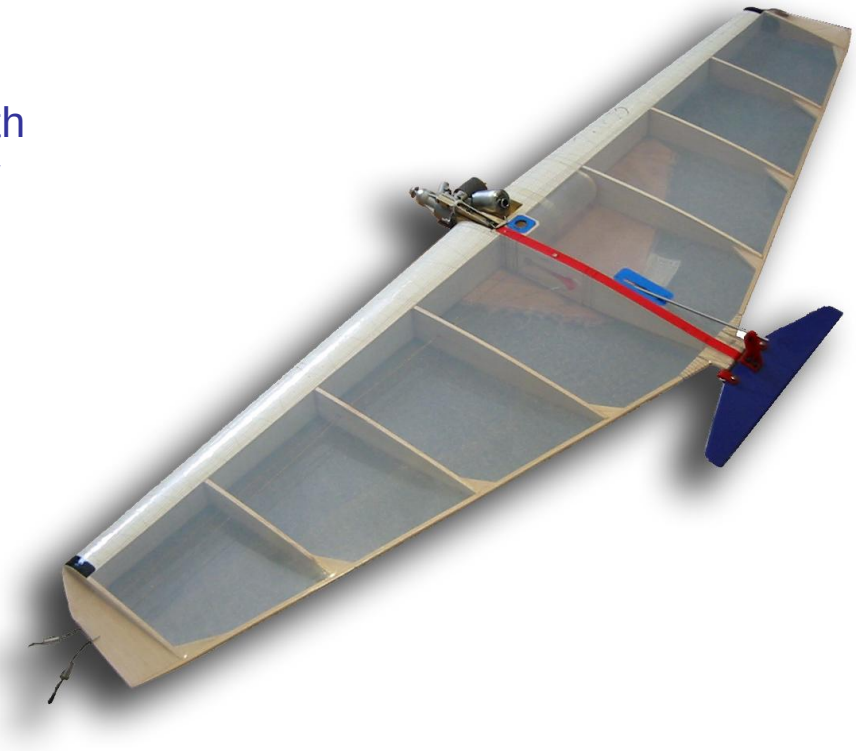
The Equipment of F2D

RTF Models – Trim Adjustments

RTF – Ready to Fiddle

Readily available RTF models are made with excellent quality and come truly ready-to-fly

To really achieve optimal performance, it is still necessary to fine tune each model to ensure that every model in your fleet behaves exactly as all the others



The Equipment of F2D

RTF Models – Trim Adjustments

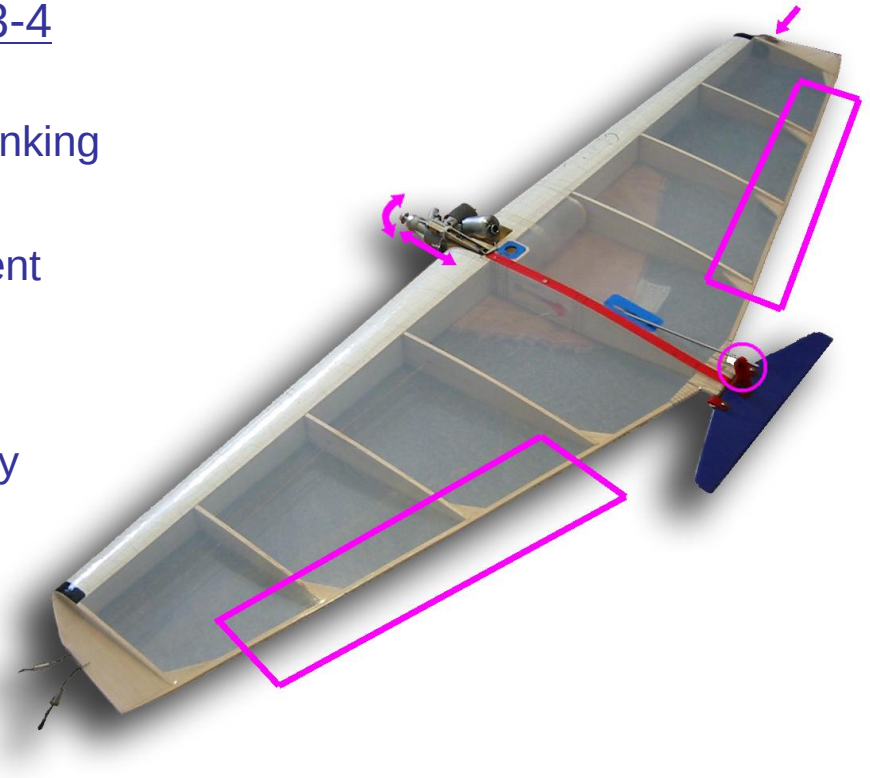
Trimming your model is as easy as 1-2-3-4

1) Wings – correct for warps by bending/re-shrinking

2) Engine – fore/aft translation for CG adjustment
– thrust-line adjustment

3) Control Horn – adjust control-throw sensitivity

4) Tip Weight – balance weight of lines



Control Line Combat

The Merits of “Fly-by-Wire”

Direct connection with the model
opens many windows not available in
other forms of aeromodeling

a) Can *feel* forces acting on the model

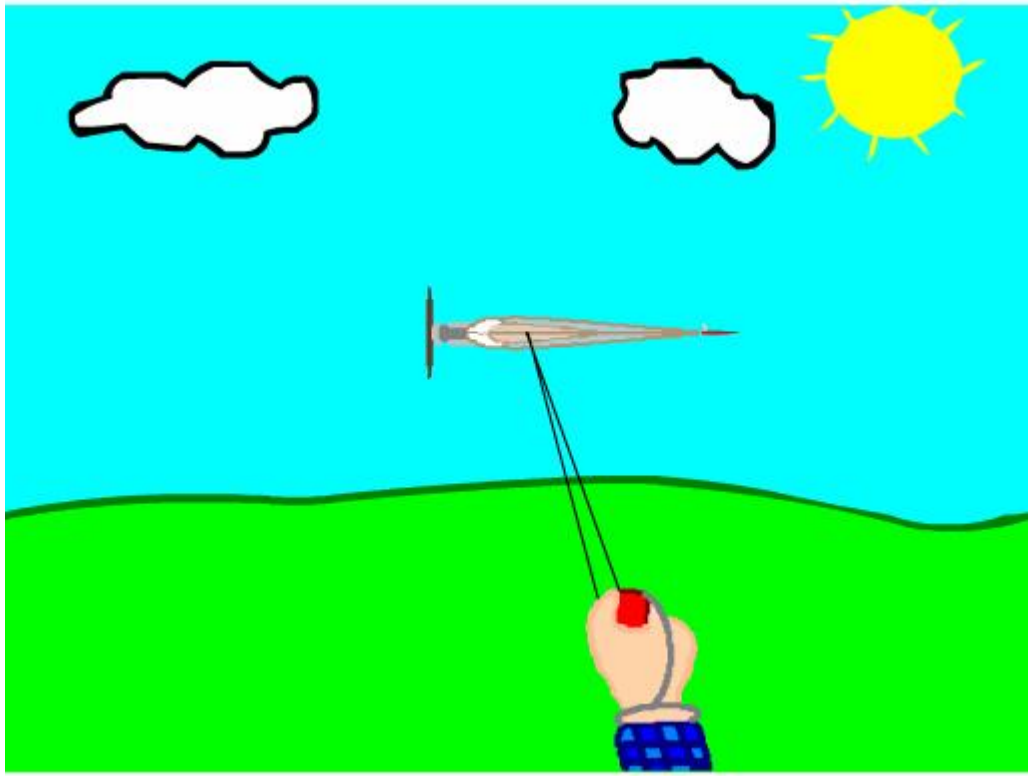
b) Flying is inherently more interactive

c) “Eyes Off” flying possible (more later)

d) Never have to go very far to pick up
the pieces if you crash

Control Line Combat

Automatic Feedback Stabilization



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Control Line Combat

Three Reasons Why C/L is Better Than R/C

"You can run, but you can't hide"

"Keep your eye on the ball!"

- Any Little League or Tennis coach

"If you don't know where you're going, how are you going to get there?"

- P. Dimotakis: Caltech Ae101, Spring 2002

"Don't become the airplane, let the airplane become a part of you"

- Me: Getting all profound and stuff, Nov. 2003

F2D Combat

Match Procedure

Timing

Minute to the Minute

Minute to Launch

Four Minute Match Period

Flying

Both pilots initially must fly level, anticlockwise

When separated by ½ lap, circle marshal gives sign to start combat

F2D Combat

Match Procedure – Team Netherlands “On the Minute”

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F2D Combat

The **Mechanics** of a Typical Pit Stop

Each pilot has 2 models, 2 engines, 2 sets of lines in the circle, ready to go

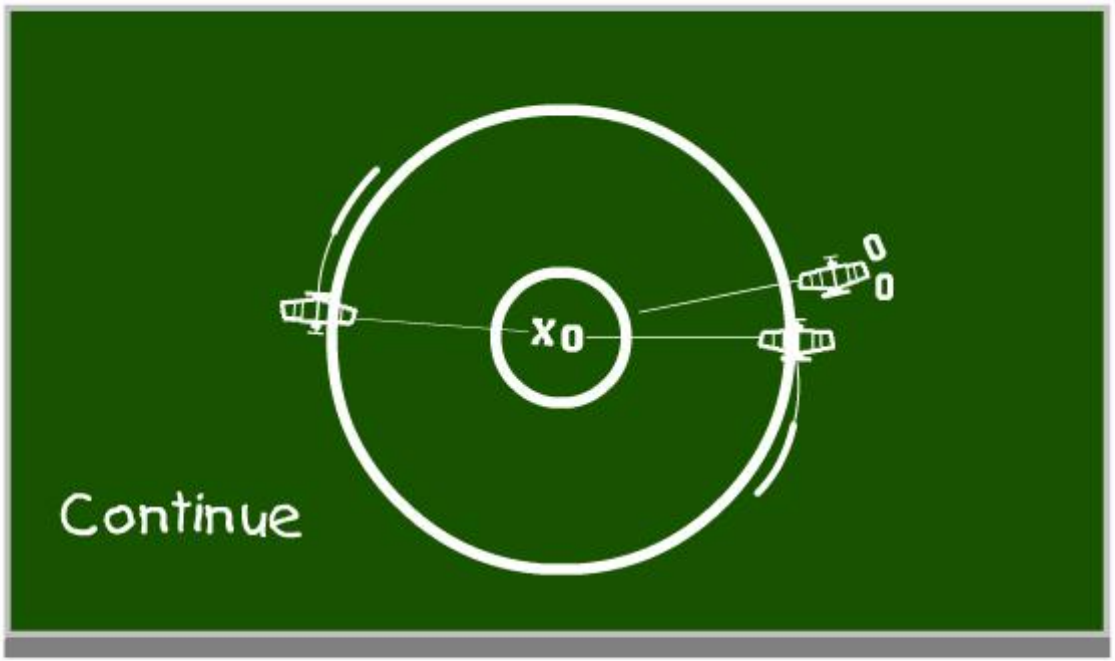
Only one engine may be running at any instant

In the event of a crash:

- One mechanic starts spare model
- Other mechanic retrieves downed model and transfers streamer to the spare

F2D Combat

The **Mechanics** of a Typical Pit Stop



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F2D Combat

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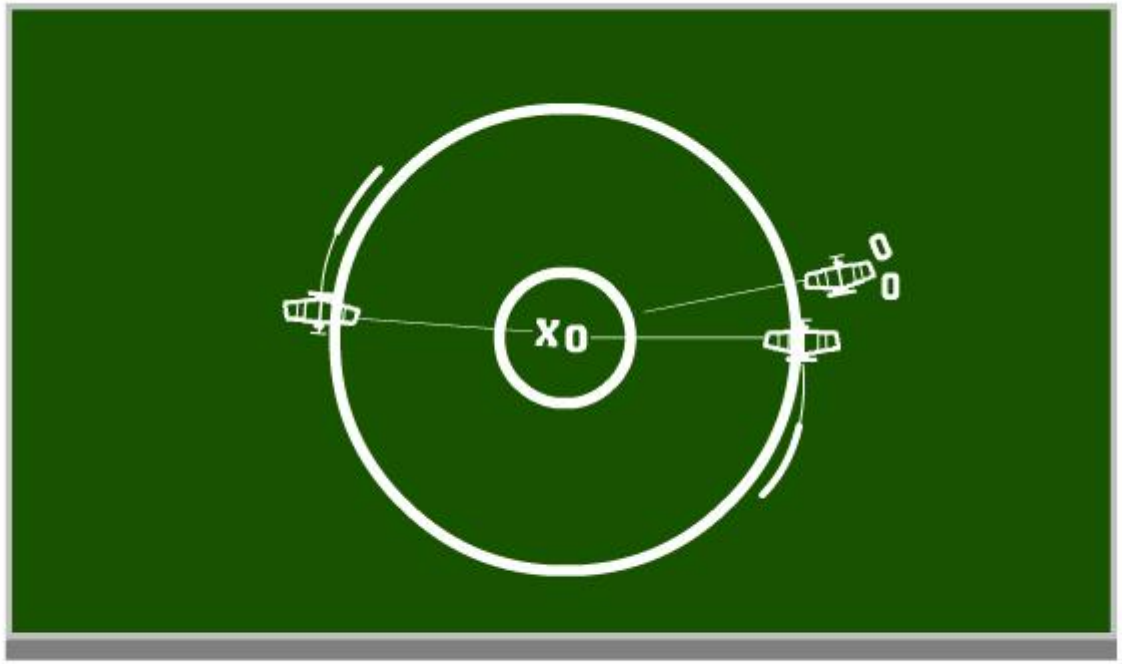

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F2D Combat

The **Mechanics** of a Typical Pit Stop – Sorting Things Out

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F2D Combat

Hard Work in the Center Circle

F2D, along with F2C and F1A are probably the most physically demanding aeromodel-sporting events

All action is confined to the 2 meter radius pilot's circle

Getting a cut requires precise alignment; a wing-slap just won't do

F2D Combat

Prepare to Enter the **Third Dimension**

While control line flight is typically thought of as occurring on a closed 2D surface, in combat there is a very important, compact, *third dimension* at one's disposal

This is one of the most interesting and challenging aspects of control line combat

F2D Combat

Prepare to Enter the **Third Dimension**

Just the Facts:

Propeller Diameter: ~ 16 cm

Streamer Width: ~ 3 cm

Pilot Circle Diameter: 4 m

Range of Pilot Arm Lengths: 60 – 70 cm

Range of Pilot Heights: 160 – 195 cm

Range of Pilot Masses: 50 – 100 kg

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F2D Combat

Working the Center Circle – Audience Participation (Yay!)

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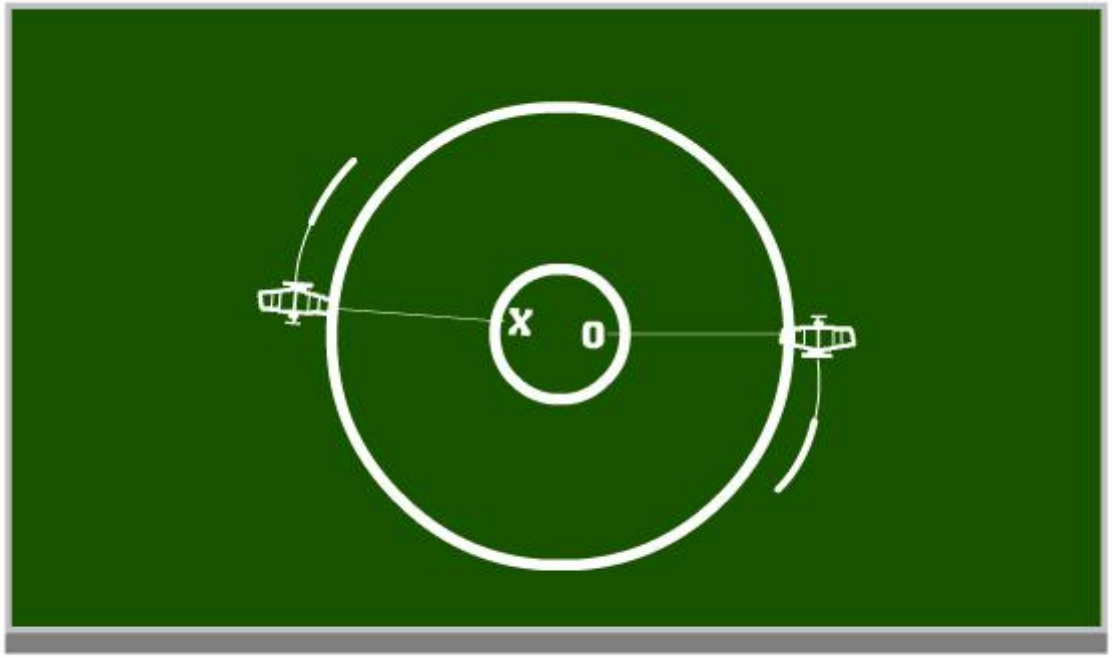
F2D Combat

Working the Center Circle



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F2D Combat

Final Remarks

Control Line Combat is **fun** and **exciting**

High quality equipment is readily available and can be tuned to your liking

The uniquely control line aspects of F2D present an interesting set of challenges and benefits, and make the sport every bit as physical as it is mental

F2D Combat

Final Remarks – For More Information

My email: rudner@mit.edu

Great Combat Info Website: www.clcombat.info

Combat in New England: www.homestead.com/necn/

Miniature Aircraft Combat Association (MACA): www.aerovents.com/maca/

2004 Control Line World Championships:

July 6 – 10, 2004: Muncie, Indiana