VIRTUAL AEROBATIC CHAMPIONSIP

Introduction
The Virtual Aerobatic Championship is like the FAI Aerobatic World Championship competition, it is an analog to real event. If you`ve never heard about it, for first meet you can check out the following links to a video:
Part 1: https://www.youtube.com/watch?v=CffOwB_5Q8k
Part 2: https://www.youtube.com/watch?v=2DGAV9v4qck

The base of this idea is like the Virtual Air Race Championship - feelings, emotions, impressions, the point is to get fun as much as possible.
This project is more difficult about to get people together thing but I have a solution - "offline" version. Well, what about special event software - I can`t say it`s more difficult than in project #1, it is just another kind. And finally what about scenery modeling, this project is much more easier than previous.

Of course this virtual competition cannot be like real in full aspects so I will write about virtual model. And one more: I want you excuse me for my English explanations because I don`t have English documentation of the competition rules, I have it in Russian language. It is totally the same but I have to translate by self. As far as I know aerobatic terms I will try to explain the basic idea of the project and will not explain how to read the sequence or what does some element mean for example. Don`t worry, I will explain all details in reading sequence before "alpha" testing (hope we will have it).

Rules of competition.
- <u>General</u>
The FAI Aerobatic World Championship is an international couple-of-days competition depends of the weather condition and schedule of flying (usually a week of duration). The objective is to fly the competition program (a bunch of sequences) the correct way. Pilots is judged by competition judges and receive points for each sequence. The one with the most points at the end of competition becomes the FAI Aerobatics World Champion.

• Several numbers of competitions different between each other. Each competition belongs to one of the Classes which mean a level of aerobatic difficulty.
• In real world there are a lot of judges. This project means presence of judges as well. The judges don`t have any precision information from pilot`s aircraft like speed or angles of bank, they judge visually sitting on the ground.
• In the reason of subjective opinion and possibility to get wrong in points there is the CIVA Fair Play System (CIVA FPS) what is computer software which does analysis of judge`s marks, correct them and as a result present the processed points for each pilot. That software was made up for minimize possibility to bribe the judges and optimize judge`s mistakes in judging process.
• There are ratings for judges and pilots. Some Classes of competition require special rating of judges and pilots to participate.

- There is a chief judge. I think in virtual project he will not influence to the results of competition but checks judges work using precision recording flight information from aircraft indicators. The results of the check procedure influence to the judge rating. Or we can give this role power to influence to results in case of too bad judging or something. Also this man is responsible to solve problems and conflicts on the judging mold.
- Virtual project will be started with "offline" model of the competition - the most easier way to realize this project. But in future this project would like to go online.
- In future the pilots of this project will make an aerobatic show on Virtual Air Race Championship for live stream translation. They will be a part of the greatest virtual "TV show".

- Elements and Sequences

Aerobatic element means the way you fly - a turn, climb, descent or another stuff - all of those are aerobatic elements. All of aerobatic elements are shown in the Aresti catalog. Every aerobatic element has his own coefficient of difficulty. In sporting column aerobatics as itself is separated by level of difficulty, there are simple (or easy?), intermediate (or medium?) and high levels but like I said I am not going deep into this right now.

Competition Sequence (if it`s correct to call, in Russia we call it more like "complex") - is a sequence of aerobatic groups. A bunch of aerobatic elements make group of elements, and a bunch of groups make the Sequence. Usually there are about 10 groups in the Sequence. Let`s take a look at simple Sequence consisting of five groups:
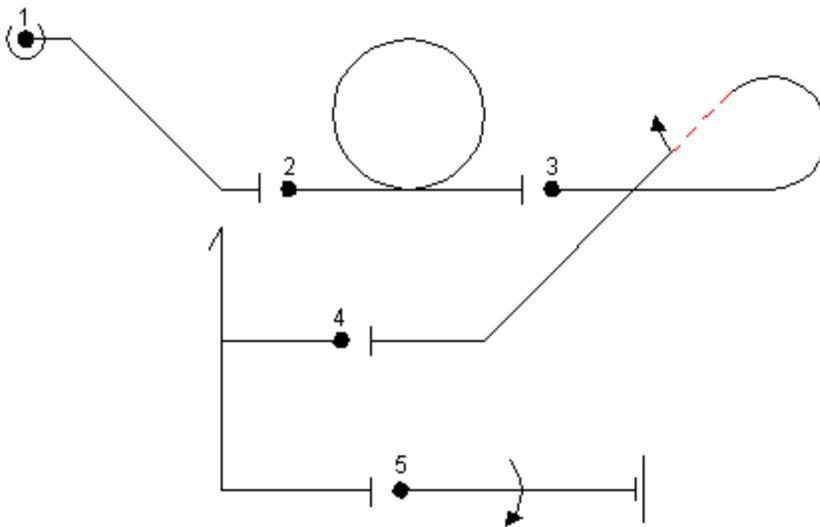
Competition Program consists of several Sequences. Judges judge flying groups of elements in Sequence and this way the pilot receive points for the Sequence. There are four different kinds of Sequences:

- Known - it is a Sequence which is published before competition so everybody knows it and

have time for training.

- Optional (may be called another way in English) - it is a Sequence which is build up by pilot, it is his personal card. Often pilots add to Sequence elements they are really good at and which are the most "expensive for points" to receive as much points as they can. Each Optional Sequence of each pilot should be accepted by judges. To be clear: pilot flies only his Optional Sequence and doesn`t fly another pilot`s.

- Unknown - it is a Sequence which is build up by judges right on the competition. In reality usually the Sequence is shown to pilots before 12-24 hours before they will fly it. So they can`t practice them in the air, if you have watched the video you might see when pilots do something like fitness - hands up, hands down, turnover - that is the only way to learn the Sequence. The point is that the pilots don`t have possibility to practice it in the air and they must fly it correct from the first try.

- Freestyle - it is the only Sequence which is judged in overall. It is a show with music. Duration of the show must be between 3.30-4 minutes. Judges don`t judge only aerobatic elements, they judge the whole show, how do they like it.

There are three forms for each Sequence: A, B and C. Form A is for judges mostly, whereas forms B and C are for pilots. Wind direction is the only difference between forms B and C (Sequence must be upwind at the beginning). Let`s take a look at real Known Sequence of the World Aerobatic Championship 2013 Advanced Class:

					2013		Form A

Pilot ID

Advanced Known

Flight #

No	Symbol	Cat. No.	K	Total K	Example marks: 7 5 0 0 Zeros and Averages: HZ PZ AV	Remarks	Pos	Item	K	Grade
1		8.8.5.1 9.4.1.2 9.1.5.3 9.1.1.1	21 9 6 6	42				**Positioning**		
2		1.3.10.4 9.12.1.4 9.1.2.4 9.1.5.1	22 7 10 2	41						
3		8.4.1.1 9.8.1.1 9.9.5.2	13 7 11	31						
4		7.2.4.1 9.1.3.2 9.8.3.1 9.1.3.3	8 4 3 6	21						
5		2.2.4.4	27	27						
6		5.2.1.1 9.9.5.4	17 11	28						
7		8.5.4.1 9.9.2.2 9.4.3.2	11 13 5	29						
8		7.4.2.2 9.1.3.6	12 10	22						
9		7.2.1.1 9.2.3.6 9.9.3.6	6 12 14	32						

Fig K	Total K
273	273

Penalties

Too Low	
Disqual Fig	
Too High	
Outs	
Interruptions	
Insertions	
Missed Slot	
Trg Violation	
Faulty Wing Rocks	

Final Freestyle

	Min	Sec
Duration		

Judges Details

Signature

Name

Number

pilot

A/C

FAI — CIVA — AEROBATICS COMMISSION

wind/vent

2x4

3/4

1/4

1/4

2x8

2x8

3/4

2x4

3x2

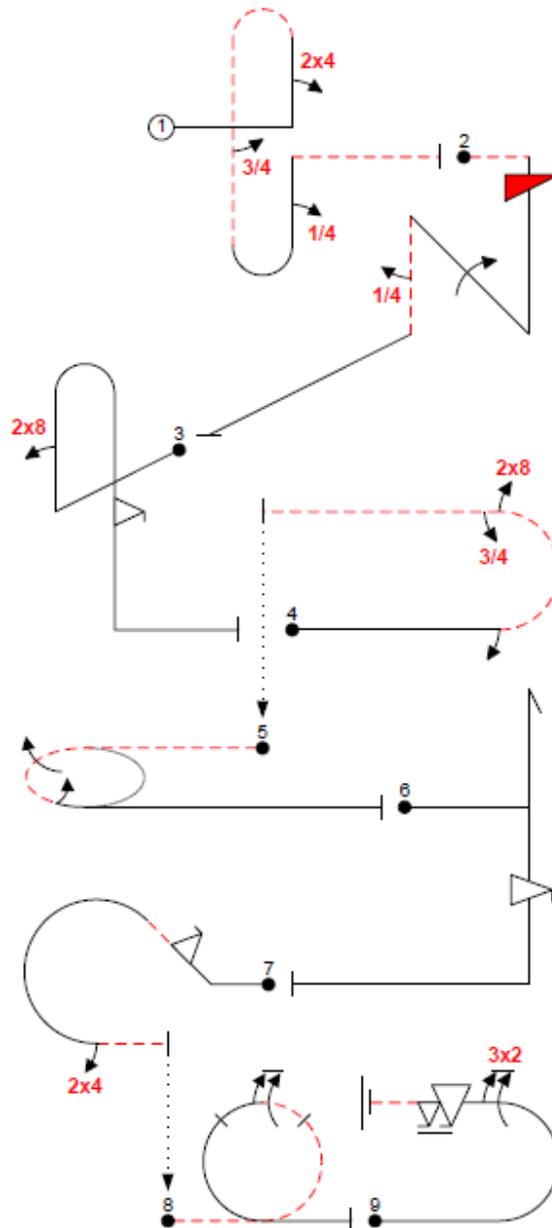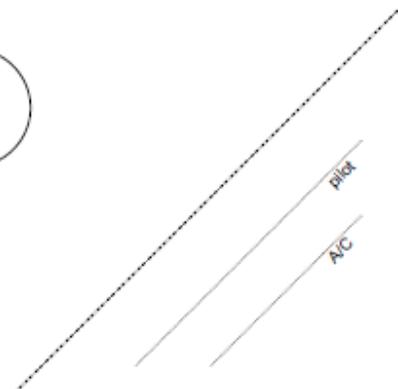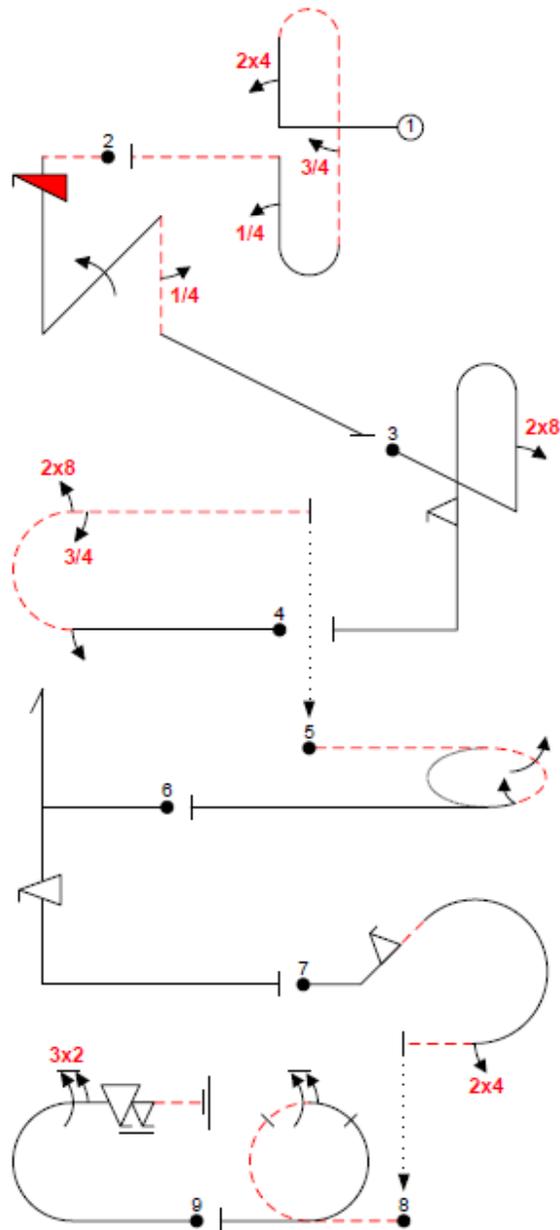|			
Fig 1	8.8.5.1 9.4.1.2 9.1.5.3 9.1.1.1	21 9 6 6	42
Fig 2	1.3.10.4 9.12.1.4 9.1.2.4 9.1.5.1	22 7 10 2	41
Fig 3	8.4.1.1 9.8.1.1 9.9.5.2	13 7 11	31
Fig 4	7.2.4.1 9.1.3.2 9.8.3.1 9.1.3.3	8 4 3 6	21
Fig 5	2.2.4.4	27	27
Fig 6	5.2.1.1 9.9.5.4	17 11	28
Fig 7	8.5.4.1 9.9.2.2 9.4.3.2	11 13 5	29
Fig 8	7.4.2.2 9.1.3.6	12 10	22
Fig 9	7.2.1.1 9.2.3.6 9.9.3.6	6 12 14	32
Total K = 273			

pilot

A/C

wind/vent

2x4

3/4

1/4

1/4

1

2

2x8

2x8

3/4

3

4

5

6

7

2x4

3x2

9

8

pilot

A/C

In real life the Sequence is printed and pilot takes it in his aircraft so he see the Sequence at any moment of his flight. In our virtual project there are three ways to realize this important moment:

1. Pilots will see transparent picture in flight simulator. Not sure we can realize it, need to talk about this with Sam or another programmer who will program.
2. Pilots use flight simulator`s kneeboard. The Sequence is uploaded to kneeboard manually. I know how to do this and can tell, write an instruction - it is easy.
3. Pilots just print prepared PDF file with Sequence.

- Championship formats

There are several Classes of championships. Class means level of difficulty. In our project I think we have to start with Classes as follows:

- Sportsman - for beginners, virtual model of Class, combination of real Primary and Sportsman Classes.

Sportsman Class	
Pilots:	Any interested pilots can participate in the championship. 10 pilots as minimum.
Judges:	Any interested judges can participate in the championship.
Aircraft:	Any GA aircraft with propeller type of engine.
Rounds:	1. Standings
Sequences:	1. Known 2. Known 3. Optional
Ratings:	Each pilot received 50% or more of maximum points will get the "Sportsman III" rating.
Approx. duration:	5-6 weeks for "offline" version including 2-3 weeks for judging and publishing results.

- Advanced - for advanced aerobatic pilots, virtual model of Class, combination of real Advanced and Unlimited Classes.

Advanced Class	
Pilots:	"Sportsman III" rating is required. 10 pilots as minimum.
Judges:	Any interested judges can participate in the championship (maybe will make some requirements in future).
Aircraft:	Any GA aircraft with propeller type of engine.
Rounds:	1. Qualification (pilots with 50% or more of maximum points in this round will proceed to the next leg) 2. Standings (best 10 pilots will proceed to the next leg; if there are less than 30 pilots in overall then 30% of pilots, example: 15 pilots overall, only 5 will proceed to the Final) 3. Final
Sequences:	Qualification: 1. Known Standings: 1. Optional 2. Unknown 3. Unknown Final: 1. Freestyle
Ratings:	Each pilot received 75% or more of maximum points in Qualification and Standings rounds will get the "Sportsman II" rating. 1st, 2nd and 3rd places of competition will get the "Sportsman I" rating if they successfully passed the "Sportsman II" requirements.
Approx. duration:	9-10 weeks for "offline" version including 5-6 weeks for judging and publishing results.

I`m not sure about judges rating and requirements. I think we have to start without it. We can just make up some rating for judges in percent of their mistakes.

About schedule for "offline" version of the project. A week is provided for each Sequence for pilots. Of course pilot can fly all competition program at the same day - it is his choice (if we`re talking about Sportsman Class). In Advanced Class pilots can`t do all competition program at the same day because there are a couple of rounds and need to know results.

Example of standard schedule for Sportsman Class:

- Known Sequences are published 2 weeks (as minimum) before the competition starts.
- First competition week is intended for the Known Sequence #1.
- Second competition week is intended for the Known Sequence #2.
- Third competition week is intended for the Optional Sequence.
- Next 2-3 weeks are intended for judging process and publishing results of the competition.

For understanding: if pilot did fly Sequence #2 and Optional Sequence in the first week and the

week is over that means he missed Sequence #1 and the last will be recorded as "DNS - Did Not Start". Sure you can understand if all pilots complete competition program in one day then duration of competition will be much shorter.

- Aerobatic Box

All aerobatics should be flown inside the Aerobatic Box, otherwise the pilot will receive penalties. The Aerobatic Box is an airspace in 1000x1000 meters dimension. Actually I still can`t understand about the ceiling of the Box - or it is always 1000 meters or it is up to 1000 meters from the floor altitude, but last position seems more logical (because of name - "box", in Russia we call it more like "cube"), so I believe the ceiling of the Box in our virtual project will be 1200 meters (3937 feet AGL) and the floor will be 200 meters (656 feet AGL). In real life the floor level depends of the Class of competition but I don`t want to realize it.
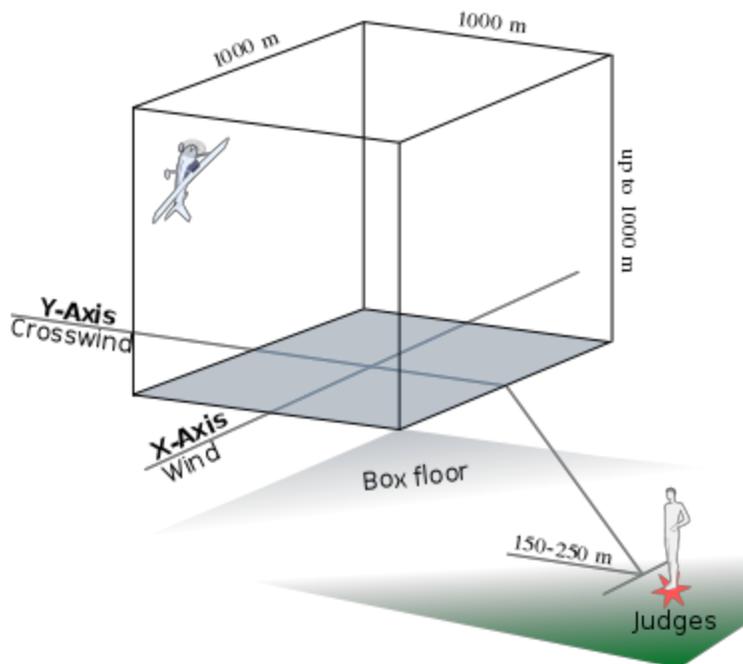
As you can see at the picture the judges sit under and a bit away from the Box, usually 250 meters diagonal away. In our virtual project we will try to simulate this positions for judges.

The box is not far from the airfield. The Box allocates above field with no obstacles like high trees or buildings. If there is a suitable field near the runway then usually the Box allocates right there. The Box is marked on ground by white panels in 3x9 meters dimension like at the picture below:

50 м

50 м

1000 м

50 м

50 м

150 - 250 м

judges

1000 м
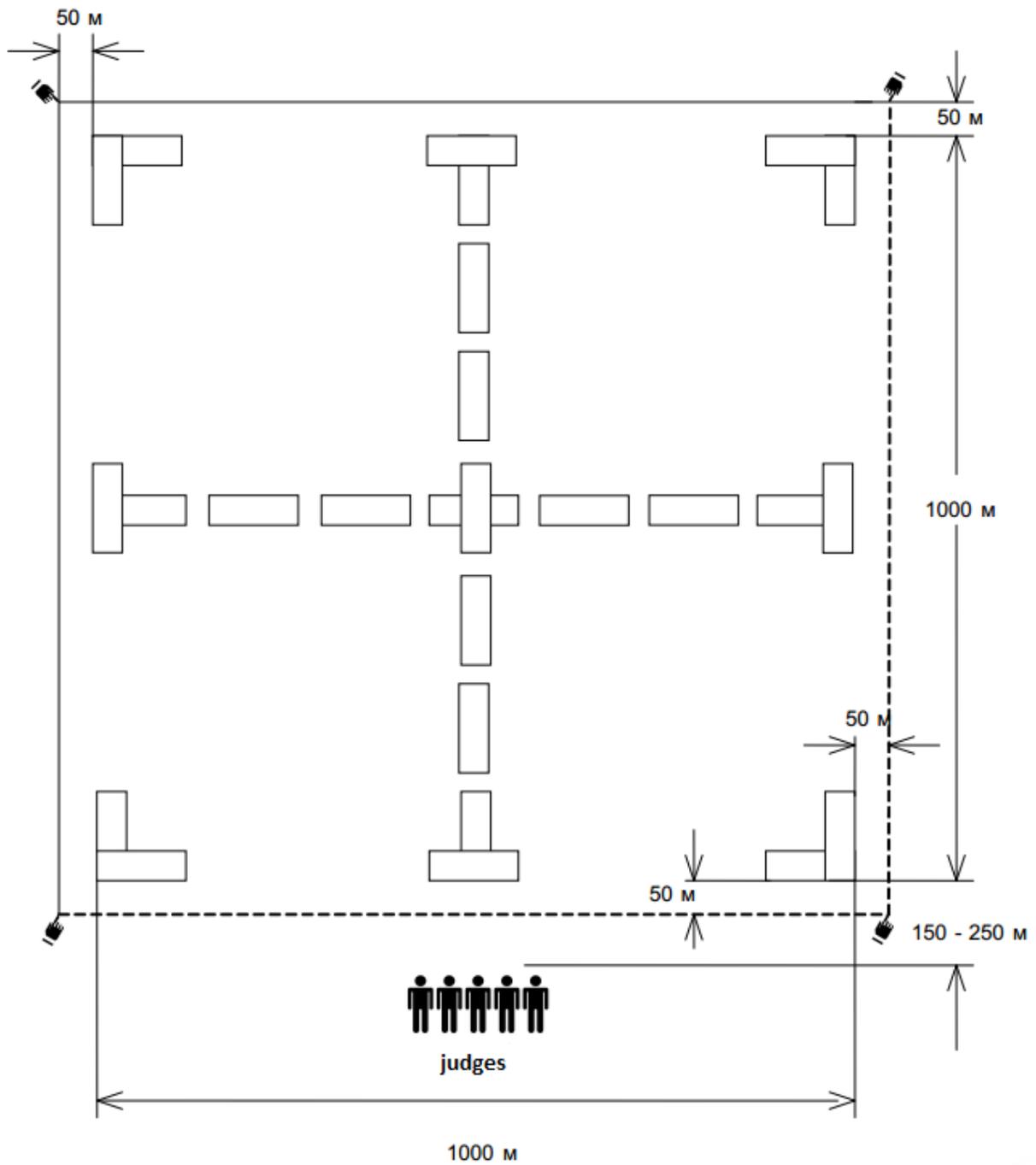
Like I said earlier the flying is upwind at the beginning. Organization committee makes additional marks to show what direction pilots should enter the Box. But that is how happens in real, in our virtual project I don`t think we can handle this moment (especially if pilots have different weather).

How do pilots know are they inside the Box? They use ground marks for horizontal orientation and altimeter indicator in their aircraft for vertical. The same way it will be in our project.

- Judging

There are 5 judges as minimum for each competition in current project. The judging process requires special competition software. The software will be with two separated modes:

- Mode "Judge".
- Mode "Chief Judge".

The difference between these modes is in flight information. The software records aircraft data but cut flight instruments or another way to understand the true angle of bank for example. So judges will see the aircraft and must judge visually. But chief judge will have precision information - that is the difference - because chief judge have to make the right ratings to judges.

About points. I will not go deep in that, I have manual about marks and another stuff, will explain it closer to "alpha" test but I have to give some basic information:

- I expect computer judging only about inside/outside the Box moment. When pilot goes outside he will receive penalties. I expect it will be automatically. If pilot goes lower than 100 meters - it is DSQ.
- Judges have to judge aerobatic groups (a bunch of elements). Judges start from 10 points - it is a maximum mark, and add penalties for each wrong way of aerobatics. For example: if pilot did the element (the group to be more correct) perfectly - it is 10 points.
- Second moment of previous position is elements coefficient. Judge`s mark for the group is multiplied to the coefficient of this group - that is the final point for the group.
- After all judges have completed with their work, the CIVA FPS starts. FPS is about mathematics. I will not explain this moment because it is a really difficult system but I have manual for it (by the way, anyone can see about all this stuff on official FAI website).

- Aircrafts

Like I said earlier I think we can able to allow any of GA aircraft with propeller type of engine.
I can recommend the following aircrafts:

Edge 540 - freeware somewhere on the internet.
Extra 300 - freeware as default and payware by Alabeo.
Sukhoi SU-26 - payware by Alabeo.
Pitts S-2 - payware by Alabeo.
Yak-52 - saw some models but didn`t try, can`t say anything (but have flown on this aircraft in real life - great!).

- Weather and hacking

Like in Virtual Air Race Championship we can`t handle the weather.

Hacking. Actually this moment is like in previous project. If somebody wants to use Cessna 172 - okay. If somebody will try to hack and replace config to use some reactive aircraft - ha, go ahead, it will be funny.

I can say the project is well protected.

Realization
- Programming

The base of the client is the same. Well, the client must be separated into 3 parts or it will be 3 different clients.

- For Pilots. Reading information about flight, sending information to server (or web).
- For Judges. Receiving data package of the whole flight and drawing flight session. Plus special form for marks (Sequence Form A). Sending results to server (or web).
- For chief judge. The same like judges have but with indicators so chief judge can see precision data of the flight. Plus marks of judges and special form to mark judge`s work and give them rating (in percent of correct marks). Sending results to server (or web).

About recording.
- It is very important to record every motion, every coordinates and so forth. Exactly full data package - that is what we need. It is not important about speed of sending data to server or special web, it is more about speed of reading data from flight simulator or something like this.
- Second moment should be easy - saving information somewhere until deleting.

About drawing:

- We have to paint the Box in software and program coordinates.
- We have to paint a 3D model of aircraft and put him into the software.
- Third step - to make this animated aircraft fly according to received data about pilot`s flight. For more understanding: Server or special Web service saves all data about all pilots flights, every motion, every evolution. This data package is sending to Judge client and has to be animated to simulate visual work.

About Sequence in flight simulator. I had talked with some programmer in 2011 and he said he can influence to flight simulator via FSUIPC. Then I saw personally how it works. Via FSUIPC we can block some aircraft functions like, for example, starting engines or movements, but it is not a point. Everybody knows a linear ATIS when we switch to the ATC frequency or linear information about weather changes using Active Sky for example. So that programmer said he can put information the same way as well. I didn`t ask him about pictures, he told me about text. So I think if this way we will be able to put a picture in flight simulator then we can make it to use Sequence thing more comfortable way.

About Unknown Sequence. My idea about that moment is to create a special request form in pilot`s client. How will that work:

- There is a button like "Download Unknown Sequence" in the client.
- Pilot clicks on the button and the client gives a message box with text like "After downloading Unknown Sequence you will have 24 hours to fly it, do you want to download?".
- Pilot clicks "Yes, download the Sequence". Client receive the Sequence forms from server or special web.
- When the Sequence is downloaded to client and both (client and server or web) understand that operation is done, clock starts. Clock should be on server or web because it is 24/7.
- If after 24 hours there isn`t a record from client about flying Unknown Sequence - status "DNS - Did Not Start"

About Freestyle Sequence. We don`t worry about how pilot will fly it. He can turn on his music and try to do what he wants and what he expected. The most interesting moment in that Sequence is how it will work for judges. That`s my idea:

- Judge`s client plays whole flight of the pilot starting from outside of the Box. System doesn`t understand what does aircraft do correct elements or not, the only thing what the software understand is when pilot goes inside and outside of the Box.
- Second moment - each pilot upload to our server or web his music. This music has to be downloaded to judge`s client.
- When the pilot crosses the line of the Box so software understand he enter the Box, the client starts to play music automatically.

About CIVA FPS. I am not going to explain system now, it is too difficult and a lot of mathematics. But for sure I will present all the stuff to realize this system.

- <u>Scenery modeling</u>

Scenery modeling is much more easier than in previous project - just need to add white marks on the ground (Aerobatic Box) in the chosen scenery.

Discussion: http://www.cixvfrclub.org.uk/forums/index.php?topic=10107.0