MV3204
Computer Graphics using X3D/VRML
FY05/Q02
Final Project Description and Analysis

Aircraft Formation Visualization: Using X3D for Building a Part-Task Trainer

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Within any community of military pilots, there exists the requirement to indoctrinate newly winged aviators to the common practices and Standard Operating Procedures peculiar to that sect. Rote memorization is traditionally the predominant method that a young pilot uses to acquire the necessary knowledge; there is at first no time for a thorough ‘understanding’ of the concepts behind doing things a certain way. It is only during the years that follow an initial training syllabus that a pilot will gradually obtain general comprehension of doctrinal tactics, and this the ability to generate new tactics ‘on the fly’ that hold to those doctrinal elements.

In one simplistic case, pilots are introduced early to the idea of flying in formation as a method of maintaining unit integrity, maximizing mutual support, and equalizing fuel flow between individual aircraft. Elementary formations are readily mastered, but grasping the geometry of more advanced maneuvers can prove difficult. Three-dimensional spatialization and tracking of numerous moving parts is not the average human being’s forte, and although the presumption is that pilots are selected according to an above-average score on standardized spatialization tests, such a task remains a challenge.

To combat the challenge, instructors teaching first-time formation flyers often make use of creative methods; the students are directed to a nearby empty parking lot and asked to ‘fly’ the maneuvers as if they were the individual aircraft, simulating in two dimensions what is truly a three-dimensional task. This has tremendous positive training value, as judged empirically by the frequency with which a struggling student will suddenly exclaim, “I get it…” in the midst of such a walk-through.

It is conceivable that if a method existed to demonstrate formation maneuvers in three dimensions, then a coupling of that method with ‘parking lot’ training might result in an even greater transfer of training. A solid understanding of formation mechanics assists in recognizing unsafe situations while airborne. It follows that a subset of the goal of teaching the maneuver is the goal of developing pilots who are capable of recognizing a bad situation and taking quick action to extract themselves from it.

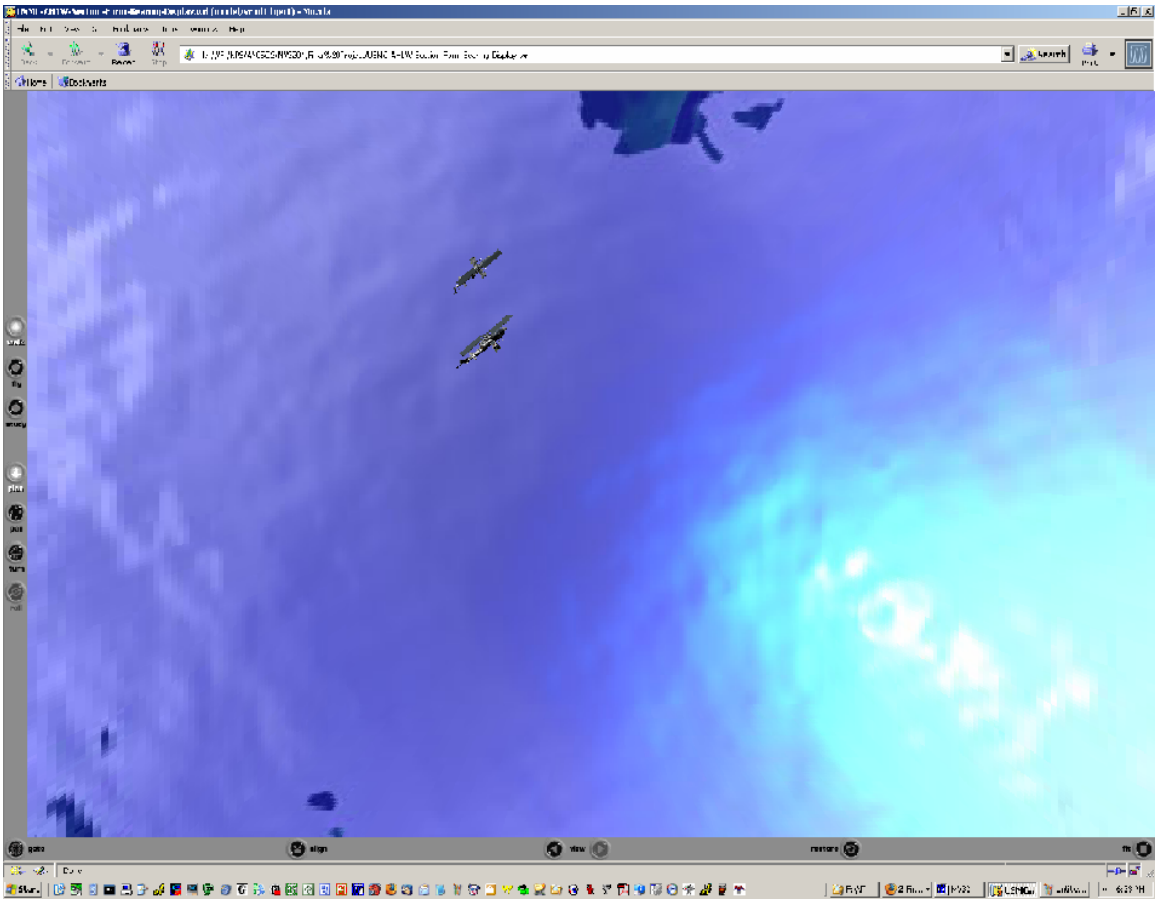
The idea that implementing a three-dimensional formation trainer would increase positive transfer has face validity, but this report does not provide experimental data to support that hypothesis. Prior to investing effort to develop such a trainer, a full cognitive task analysis and research of relevant studies would be required.

However, the effort involved in generating a proof of concept using the X3D format is not prohibitive, and as an exercise in stimulating discussion, building a single scene displaying an aircraft formation maneuver is well worth the investment.

The ‘world’ that has been built depicts the motions of two AH-1W helicopters as they conduct section turns. The learning point of the world is to understand specifically the actions of the wingman. Interpolator nodes have allowed the animation of the wingman’s roll and position to the effect of simulating that aircraft’s weaving in and out of the lead aircraft’s flight path while in a turn. The wingman does this, in part, in order to match the fuel flow rate of the lead aircraft. By varying the radius of his turn instead of the power output by his turbines, the wingman is capable of remaining in relative place with respect to the other aircraft.

Chase view behind wingman

The views afforded by the world allow the user to see the motion from the wingman's cockpit, from behind the wingman (and slaved to his motion), from behind the section (and slaved to the lead aircraft), or from above the plane of the section, looking straight down.

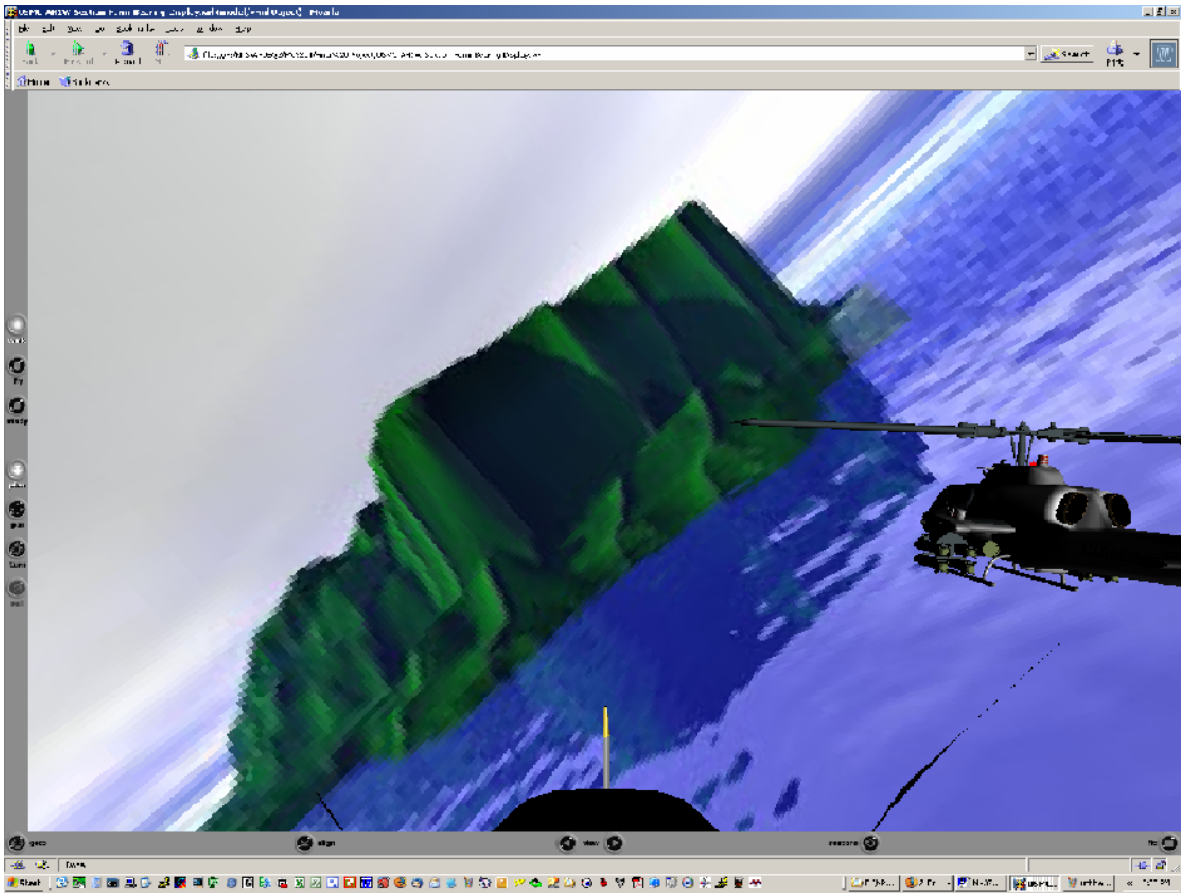


Overhead view of the section

The virtue of the world of itself is not impressive; the cruise turn idea is not one of the more difficult concepts to master. The realization that the scene could be expanded to include any number of other maneuver demonstrations reveals the true power of the format. Any view, from any cockpit, and for any size of formation (section, division, flight) could be generated to assist in building student comprehension.

Of merit is the argument that flight simulators already are capable of accomplishing the described task. This may be true for communities that possess multiple linked simulators, and it presumably enhances the learning of formation flight much better than could a 'fishtank VR' simulator. However, certain realities mitigate that

effectiveness. There exist only two simulators for the AH-1W; there are on opposite national coasts, and they are not linked. The time requirement for using a simulator for other than a fully scripted training sortie would be wasteful; there are not normally enough simulator periods available for the syllabus training already required.



Wingman cockpit view

Given a set of training maneuvers rendered from X3D format, however, such data could be distributed to individual flight students along with other training materials. Prior to a formation flight, and at their own pace, students could view the maneuvers until they were confident with the concepts.

Further work is required to determine if this idea merits investment of resources. The real question is not whether positive training transfer would occur with the use of a three-dimensional concepts trainer, but rather by how much and at what expense. There have been no flight mishaps resulting from a student's failure to

understand a maneuver, although there has been more than instance when such a failure would have resulted in catastrophe were it not for the quick judgment and quicker hands of the instructor pilot with that student. A survey of instructor pilots would likely generate positive responses were the question asked, “Would you support a trainer that improved initial student ability while airborne?” Whether a part-task trainer such as the one described in this document is the appropriate solution remains to be discovered.

Errata

Tools used in the creation of the X3D file *"USMC-AH1W-Section-Form-Bearing-Display.x3d":*

- Wings3D, an open-source modeling package, for creation of the AH-1W aircraft.

  Available for download at http://www.wings3d.com/

- Goldwave, a commercial audio editor package, for creation of the sound of helicopter rotors turning.

  Available for download at http://www.goldwave.com/

- Jane's Online Database, a vast repository of data on all things military, reference to the shape and color of the AH-1W model.

  Available for reference at http://www2.janes.com/ (subscription based)

- X3D-Edit, a graphics file editor for generation of the section scene and all animations.

  Available at http://www.web3d.org/x3d/content/X3D-EditAutoInstall/Web_Installers/install.htm