Project: Attitude and Direction Indicator

The Attitude Direction Indicator shows the roll and pitch of the A/C. The upper half of the display is blue (sky) the lower half is brown (terrain). The borderline between the halves is the horizon. The horizontal bar represents the A/C in relation to the horizon. The white bars (one horizontal, the other one vertical) are the indicators when in ILS modus, showing the aircraft's position in relation to the glide-slope and inbound vector of the runway. If the A/C outside the max. ranges of GS and Course, the bars are locked on one side of the indicator.

Goal:
- Write an Ada95 program to create the display shown below (Attitude and Direction Indicator). Use the AdaOpenGL binding to create the graphics.

![Figure 1. Attitude and Direction Indicator](http://xflight.powerweb.de/original/parts:center_console/adi/adi_01.jpg)

The openGL package can be found at [http://adaopengl.sourceforge.net/](http://adaopengl.sourceforge.net/)
- The user should be able to control pitch and roll from the keyboard. You may assign the keys ahead of time and display it when the program starts.

Issues to be considered are:
- What is the maximum pitch rate/roll rate of the aircraft?
- How long does it take to update the display once the user enters a command?
- Write a two page memo to the designers of the JSF based on your project, explaining what you think the key design issues in designing the display are.
The specification of the frame of reference is one of the most significant design questions for spatial displays, since it determines from where the situation is depicted and which variables are presented as dominant cues.

Inside-out refers to a presentation of the world related information as it would be observed from within the aircraft. Outside-in refers to a viewpoint which is stabilized in a world-referenced system. Stokes et al. (1990) present three principles that should influence the choice:

- The principle of the moving part.
- Constancy of reference frames.
- The principle of frequency separation.

The principle of the moving part assumes that people have certain expectations about what actually moves in a system. The element that moves on the display should be the same and move in the same direction as the operator's expectation of motion. The principle of constancy of reference frames is based on the fact that humans have a difficult time rapidly reorienting between different frames of reference. When an instrument represents an abstraction of the real world and the user is required to switch between the instrument and the real world, different frames of reference can result in control blunders. This is caused by the fact that to compensate for a given display movement, the required direction of the control action may be opposite between the two frames of reference.

In case of an artificial presentation of the outside world, the principle of the constancy of reference frames leads to the conclusion that, to maintain static compatibility with the outside worldview, an inside-out frame of reference should be used. However, the principle of the moving part suggests, that to maintain dynamic compatibility, the movement of the display should be consistent with the pilot's mental representation that the aircraft moves, and hence an outside-in frame of reference is required (Johnson and Roscoe, 1972). The attitude direction indicator (ADI) presents the pitch and bank of the aircraft relative to a depiction of the horizon. In general a so-called inside-out frame of reference is used (fixed airplane symbol against a moving horizon).

With an outside-in frame-of reference, the horizon is fixed and the aircraft rolls right and left and pitches up and down. To prevent the aircraft symbol from going off the scale, the complete pitch range must be visible, posing quite a design challenge since the combined range and resolution requirements can result in a rather large display.

Russian aircraft employ a hybrid solution, in which the aircraft symbol rolls but is fixed in the vertical direction, and the artificial horizon translates in the vertical direction to convey pitch information. By allowing the aircraft symbol to roll against a fixed background, the principle of control display motion compatibility is satisfied. When regarding an attitude indicator as a display of which the error must be zeroed, control reversals can results. Therefore, an inside-out frame of reference must convey the illusion that the aircraft is moving.