Analysis and Design of a "Heads Up" Display (HUD)

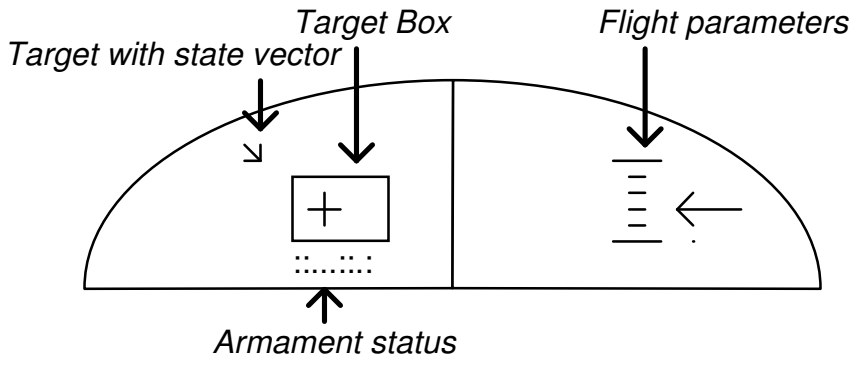

Figure 1: Pilot's view of a typical HUD

During target engagement by a high-performance aircraft, it is critical that the man/machine interface be kept very simple. There is no time to scan the cockpit for flight information in close engagements, and the pilot must watch the target at all times.

A solution to this problem is to create a "heads up" display (HUD) so that the pilot may observe both the target and critical flight parameters simultaneously. In most HUDs in aircraft, the flight information is projected onto the windshield of the canopy so that the pilot may continually look outside the aircraft. Figure 1 shows a typical HUD. The HUD concept has been developed by the US DoD for some time, and we are now finding this good idea filtering into the commercial sector, with the window-oriented speed and status display now emerging as an option on certain automobiles.

The object of the HUD is to provide sufficient information with low complexity. The correct scenario is for the pilot to fly the aircraft so that the selected target falls within the target box. Firing during that time yields a high probability for a hit. Assuming that the pilot has selected a trainable gun (that is, one that may be aimed automatically within a few degrees), the cursor inside the box points to where the gun is currently aimed. In addition, depending upon the target range and type of armament selected, the target box will vary in size, indicating the effective radius of the weapon. As the aircraft gets closer to the target, the box grows in size. The display also provides a presentation of critical flight parameters, such as altitude and angle of attack, plus a summary of the armament status. Furthermore, an arrow is superimposed on top of the selected target. This arrow not only assures the pilot that the correct target is being tracked, but also presents the target's predicted direction of flight.

In systems as complex as aircraft, there will exist many embedded subsystems. When we design our HUD, there will certainly be physical constraints on the solution that are beyond our control: we simply cannot redesign the entire aircraft to meet our needs. Most likely, even before we start the design of our particular subsystem (the HUD), another design team has already made a functional allocation of each major aircraft subsystem, such as the avionics computer or radar subsystem. As a result, our HUD will have to depend upon several predefined and usually static interfaces.

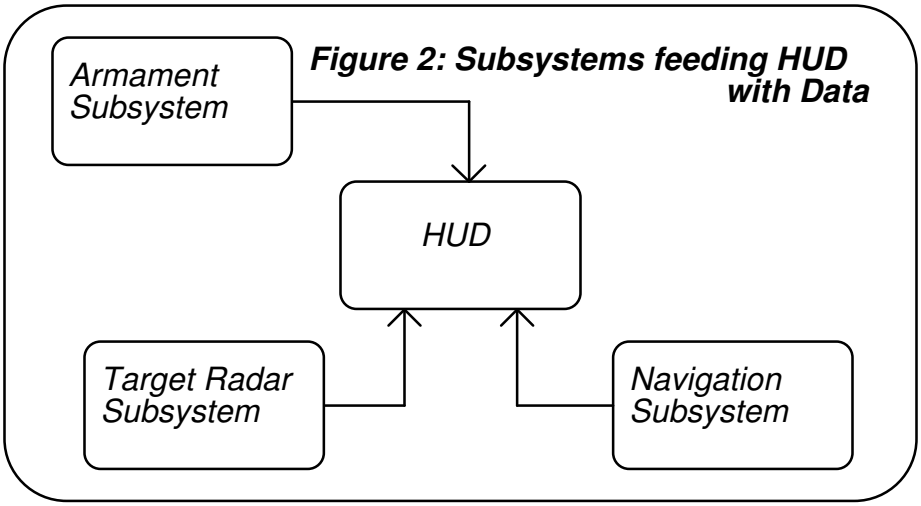

Figure 2: Subsystems feeding HUD with Data

Figure 2 illustrates the functional allocation of the aircraft subsystems from the perspective of the HUD. As you can see, the major subsystems are the Armament Subsystem, which controls weapon resources and targeting, the Navigation Subsystem, which includes all flight avionics equipment for aircraft guidance and control, and the Target Radar Subsystem, which acquires and tracks target aircraft.

Problem [10 points]: perform an object-oriented analysis and a top-level design of a HUD as described. Create and present a data dictionary, an entity-relationship diagram, and a data flow diagram which illustrates your understanding of the problem as your analysis phase. Select the classes and objects during your design phase and present the details of the member data and functions associated with these classes and objects. Include each subsystem interface in your design along with the details of the interface. Allow for subsystems to be duplicated, so concentrate on a class-oriented design.