Why Displacement Matters: A Green/Purple Debate

Game Scale And Basic Equations

1 Hex = 10 km, 1 turn = 64 seconds. (DV scale, VMS/FT have no specified scale)
Velocity=a*t, displacement=0.5*a*t². A velocity change of 2 hexes/turn is 0.5 g of thrust.

The Fundemental Problem:

The example to the right shows three vector plots for a multi-turn linear thrust from an at-rest state. Black circles show unit positions at the end of a constant acceleration. Gray circles show positions after the engines are turned off, with the unit drifting at its new velocity.

The example in the green box is thrust 2 in the Full Thrust-style Vector Movement System (VMS). VMS assumes that thrust is either instantaneous, or that the displacement on the first turn of thrust is equal to the velocity change.

The first purple box is thrust 1 in DV scale, where thrust 1 equates to one additional hex of movement (displacement) on the turn of thrust, and a velocity change of 2 hexes/turn. This matches the velocity change in the thrust 2 VMS example

The second purple box is thrust 2 in DV scale. This matches the turn 1 displacement of the thrust 2 VMS example, but has a greater discrepancy in velocity change. It is the only example where VMS and DV place a ship in the same hex at the same point in time.

Because it measures from a fixed point, the graphic at right understates the full impact of these discrepancies. Spaceships aren't fixed points, and velocity change and position are two parts of a tactical environment.

The error increases linearly with the rate of thrust. Going to thrust 4 results in double the error above; two units thrusting towards each other at thrust 4 in VMS would have a combined positional error of 8 hexes after the first turn, which is significant in most games that can be played on a hex map, and thrust 4 in the context of the DV game scale is fairly modest. As the game progresses, the errors accumulate and multiply over time, and also tend to expand at the rate of (n^2-n)^t where n is the number of units on the map engaging in thrust and t is the number of turns the game has progressed.

Facing Changes: A New Problem

At left is a blue bounding box that shows what happens when facing changes are allowed in the middle of a burn. Assuming the turn took place at the exact midpoint of the burn, there would be no displacement on the hex grid in proper Newtonian movement. Making the vector change and displacement equal results in a significant positional error when dealing with burns of less than one time increment. As the number of facing changes during a burn increases, the rate of error increases similarly.

Multiple Ship Example

The graphic below shows how each discrepancy is magnified by both the length of the game and the number of units in play. Each star represents the starting point for a unit. Dark green/purple circles indicate positions obtained via displacement+velocity drift. When VMS and DV would place the unit in the same hex, a split green/purple circle is used. The lighter color labels indicate where a unit would be after drifting at velocity. In the illustration below, thrust 1 equates to half a g of thrust, and assumes that VMS and DV are equivilant in displacement, rather than in velocity change. Unit A has initial vectors of 4 in D, 2 in C and does not thrust on turn 1, then thrusts for 4 in F on turn 2. Unit B starts at rest, thrusts at 7 in C on turn 1, and thrusts at 4 in A on turn 2. Unit C has an initial vector of 3 in E, thrusts at 5 in B on turn 1, and stops thrust on turn 2. All three ships drift on turn 3.   Compare the discrepancies in expected positions of on turn 3. In particular, note the radically different positions of units A and B. Rather than having a range 12 pass at the end of turn 2 (VMS), they actually had a range 4 shot in DV, while by turn 3 they've already passed each other with 16 hexes of separation, versus a range 11 shot in VMS.

Right-side vector plots:
- 4 V=16
- 4 V=6
- 3 V=12
- 4 V=6
- 3 V=6
- 3 V=6
- 2 V=8
- 2 V=4
- 2 V=4
- 1 V=2
- 1 V=4
- 1 V=2
- V
- D
- D

Bottom diagram labels:
- Unit B, Turn 3 (VMS) Expected Position
- Unit B, Turn 1 (Both) Thrust of 7 C
- Unit A, Turn 1 (Both) No Thrust
- Unit B, Turn 2 (DV) Thrust of 4 A
- Unit C, Turn 3 (DV) No Thrust
- Unit B, Turn 3 (DV) Expected Position
- Unit A, Turn 2 (Both) Thrust of 4 F
- Unit C, Turn 2 (DV) No Thrust
- Unit A, Turn 3 (DV) Expected Position
- Unit C, Turn 3 (VMS) No Thrust
- Unit A, Turn 3 (VMS) Expected Position
- Unit C, Turn 2 (VMS) No Thrust
- Unit C, Turn 1 (Both) Thrust of 5 B