Submarine Steering in Real Oceans: VPD, $E(t)$, and Inferring A_2

Redefining Open Systems as Time-Directed Exchanges

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Abstract

We present a layman-first framework for steering a submarine with tides and currents using three practical ideas: (1) **VPD (Virtual Physical Distance)**, (2) $E(t)$ **as a field-assessment marker**, and (3) A_2 **as the unknown time-acceleration of the ocean field**. **The time field is treated here as an engineering tool, not a theory.** $E(t)$ measures how much organized push has been spent per meter and lets us reverse-calculate A_2 by comparing actual motion to a no-field baseline. Using A_2 then directs the path to make better use of power based on VPD. This makes time the control variable for open-system exchange across boundaries. We propose an updated definition of open systems where time-acceleration determines how energy is saved or spent as a result of time exchange.

1 Core Ideas in Plain Language

VPD (Virtual Physical Distance). VPD means: **when 1 Joule moves 1 kg for less or more than 1 meter because of field effects**. Against a strong tide, 1 J/1 kg may move you *less* than 1 m; with a favorable current, it may be *more* than 1 m. VPD is a simple yardstick of effectiveness.

How t decides VPD (velocity comparison). Here t is not abstract clock time. It is *set by comparing velocity to baseline distance under g.* In practice we compare how far the submarine actually travels in one second at its measured velocity to the 1 m baseline under g. If the boat covers more than 1 m in that first second, VPD>1; if less, VPD<1.

$E(t)$ **as a Marker Equation.** We define

$$E(t) = \tfrac{1}{2} M_f g^2 t, \tag{1}$$

where M_f is an effective field mass and g is gravitational acceleration. When the field influences (A_2) are not yet known, we use g as a *stand-in* so that $E(t)$ provides a baseline marker of push over time. Once VPD measurements allow us to infer A_2, we replace g with A_2:

$$E(t) = \tfrac{1}{2} M_{f,\text{eff}} A_2^2 t. \tag{2}$$

This way, $E(t)$ starts as a conservative bookkeeping tool

How to read $E(t)$ (practical guide).

- Pick a short window (e.g., 1 s) and set $t = 1$ to *normalize for g* when the field is unknown.
- Log power spent per meter over that same window to update $E(t)$ and compute VPD.
- As soon as VPD deviates from baseline, replace g with the inferred A_2 for the next control step.

Worked example (normalizing for g with $v = 4.5$ m/s). We first *normalize for g* by choosing a 1-second evaluation window so that $t = 1$ for the baseline. At baseline (no field), our marker treats 1 J/1 kg as purchasing 1 m over that window. Now measure the submarine's velocity $v = 4.5$ m/s and the power actually spent per meter (logged into $E(t)$ over the same $t = 1$ window). Comparing the baseline spending to the measured spending yields the deviation that we attribute to the field; from that deviation we *infer A_2* for that second. On the next second, we repeat: re-estimate A_2 from fresh $E(t)$ and VPD logs and update the motion accordingly.

Time Field as Engineering Tool. While the time field could be described abstractly, in this work it is insisted upon as an **engineering tool**. Just as voltmeters measure circuits or strain gauges monitor structures, $E(t)$ serves as a meter for the ocean field. It is a design variable, not speculation.

$E(t)$ as a Marker. Ocean fields are messy. We therefore use $E(t)$ as a running, testable record of *power spent per meter of progress*. It lets engineers assess the *field of the ocean* without perfectly knowing it in advance.

A_2 (Unknown Time-Acceleration of the Field). We treat the ocean's influence as an *unknown time-acceleration*, A_2. By comparing the real VPD to the *no-field baseline* (where 1 J/1 kg would produce 1 m), $E(t)$ provides the clues to *reverse-calculate* an estimate of A_2 and its *instantaneous changes*.

2 From Baseline to Inference

No-Field Baseline

Specific energy of 1 J per 1 kg ideally maps to 1 m of specific work. That is our comparison stick: *1 J/kg ⇒ 1 m* (baseline).

Measured Reality

Sea trials produce a *measured VPD*: how much distance per (1 J/1 kg) you actually get in the present tide. We log $E(t)$ (power spent per meter) along the path.

Reverse-Calculating A_2

Deviations of measured VPD from the baseline encode the *effective* A_2 acting on the vehicle. $E(t)$ acts as the marker that ties your spending curve to an A_2 profile, including *instantaneous changes* (gusts, shear, eddies). This is practical: you steer and throttle as usual, *plus* you use the inferred A_2 to pick a path that improves VPD.

3 Control Story: Time Directs the Exchange

In doing so, the controller is not theorizing about time — it is **using the time field directly as a control knob**. The submarine acts on A_2 and $E(t)$ as practical design dials. Every control cycle answers three questions:

1. **Where do we want to go?** (path)
2. **How should we point?** (direction)
3. **How should we time the push?** (use A_2 to bias coherence so that VPD improves)

In this framing, *time is the adjustable variable*: we time-align our organized push with the ocean's A_2 so that each Joule buys more effective distance.

4 Redefining Open Systems

Classically, an open system exchanges matter and energy across its boundary. Here we add a **time-directed** dimension:

> **An open system is one that exchanges matter and energy *under a controllable time-acceleration*, where the variable $A_2(t)$ defines how energy is saved or spent as a result of time exchange.**

In practice, engineers use VPD to measure effectiveness, $E(t)$ to assess the field and spending, and A_2 (inferred + applied) to direct the path and timing.

5 Sea-Trial Checklist (Minimal)

- **Baseline pass:** calm water or slack tide to establish the 1 J/1 kg $\rightarrow$ 1 m reference.
- **With/against tide:** repeat the path; record VPD and $E(t)$ logs.
- **Inference:** compute the $A_2(t)$ profile that explains the difference from baseline; watch for instantaneous changes.
- **Control update:** bias timing and route to improve VPD on the next pass.

6 Figures

VPD Baseline vs Reality

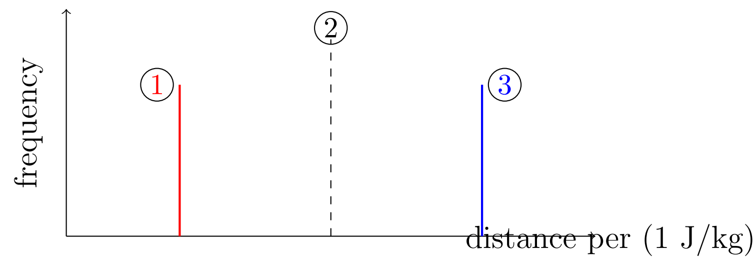


Figure notes:

1. Against tide: VPD < 1 m (1 J per 1 kg buys less distance).
2. **Baseline (1 m)**: the no-field reference (1 J/kg $\rightarrow$ 1 m).
3. With tide: VPD > 1 m (1 J per 1 kg buys more distance).

Control with A_2 as Time Dial

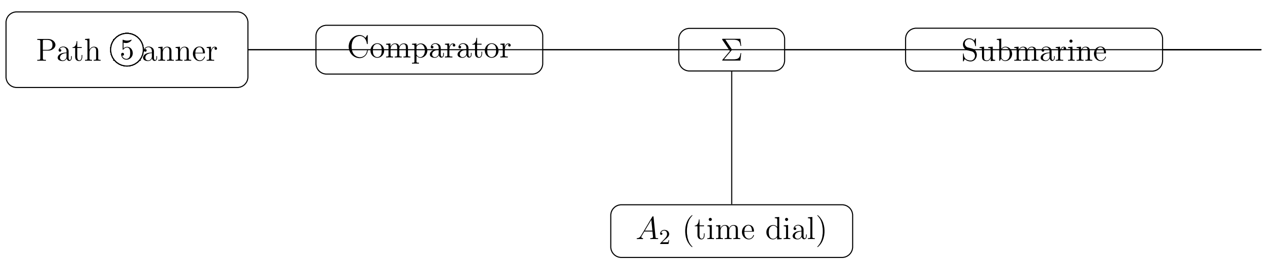


Figure notes:

1. Compare desired vs. actual path.
2. Form rudder/thrust commands.
3. Apply A_2 timing/coherence bias.
4. Send actuator commands to submarine.
5. Feedback loop carrying $E(t)$ and VPD measurements.

7 Conclusion

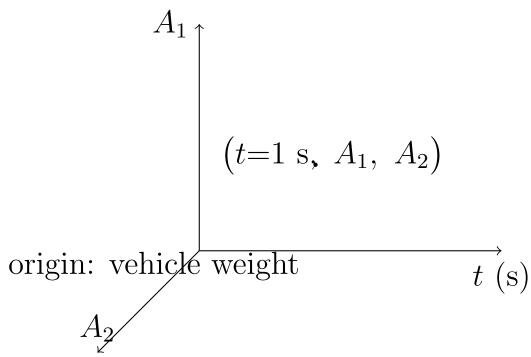
VPD tells us what each Joule per kilogram *really buys* in moving water. $E(t)$ makes the field assessable from power spent per meter, and it supports *reverse* inference of the unknown time-acceleration A_2. Using A_2 to time-align our push turns *time* into the operative control variable for open-system exchange across boundaries. On this basis we update the definition of open systems:

The contribution is not theoretical: it is an **engineering stance**. $E(t)$, VPD, and A_2 turn the time field into a real design dial for submarines in real oceans. The time field is not a theory but an engineering tool. time-acceleration governs how energy is saved or spent as a consequence of time exchange.

8 Defining the Time Field (Cartesian View)

Consider a Cartesian volume with axes: t (seconds), A_1 (vehicle acceleration under net force), and A_2 (field acceleration inferred each window). Place the **vehicle's weight** at the origin. Because one second is a unit on all axes, we can compare and combine (t, A_1, A_2) each control step. In this 3D picture, the *time field* is the evolving volume spanned by $(t, A_1(t), A_2(t))$. $E(t)$ lives inside this field: it quantifies how much organized push is realized given the current coordinates.

Sketch: Time Field Axes



9 Control Story: Time-Directed Exchange

Each window answers three questions: (1) path, (2) direction, (3) timing via A_2 to improve VPD. In doing so, the controller uses the time field as a *design dial*: update A_2 from VPD and $E(t)$ and apply it in the next window.

10 Sea-Trial Checklist

- Baseline pass (slack tide): establish the t=1 normalization and record $E(t)$.
- With/against tide: log VPD and $E(t)$; infer $A_2(t)$; update route and timing.
- Iterate windows: recompute A_2 and adjust control to improve VPD.