

The Nomadness Report

by **Steven K. Roberts,**
Nomadic Research Labs

A Compendium of Boat
Hacking and Gonzo
Engineering

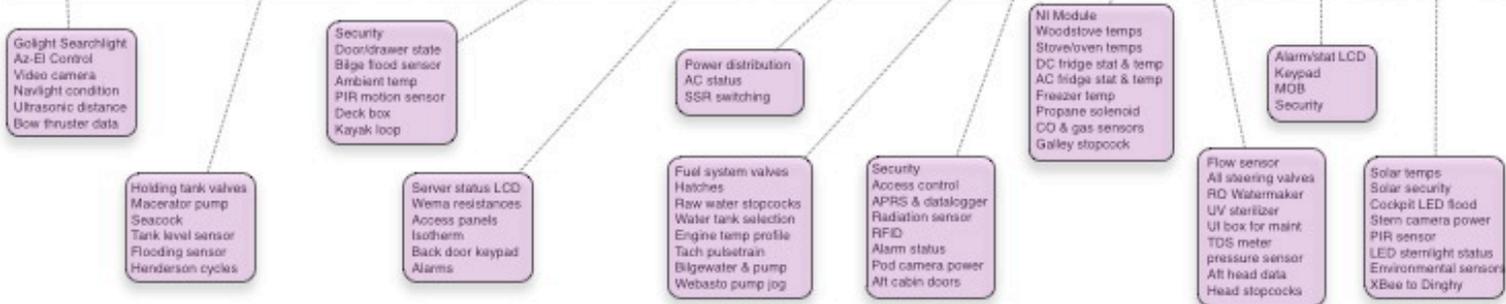
FULL COLLECTION:
APRIL 2011 -
JANUARY 2013

Plus added notes and resources

THE NOMADNESS REPORT

ISSUE #1
APR 24, 2011

A WEEKLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



WELCOME TO NOMADNESS!

This is the first issue of the weekly *Nomadness Report*, the ongoing narrative of an insanely geeky boat project that is the distant descendant of the *BEHEMOTH* computerized recumbent bicycle and *Microship* amphibian pedal/solar/sail micro-trimaran.

Extensive background about all this is already available on my [website](#), so I won't spend time here with history. There is an established *Nomadness* blog in addition to this newsletter, and it will become oriented to articles about completed subsystems. But this orthogonal publication will relate the process as it unfolds... with all the geek humor, adventure interludes, wrong turns, smoke tests, wall-staring, and gonzo engineering. I have maintained public narratives like this with previous projects, and it builds a sense of community involvement through ongoing contact... I welcome your comments as this unfolds.

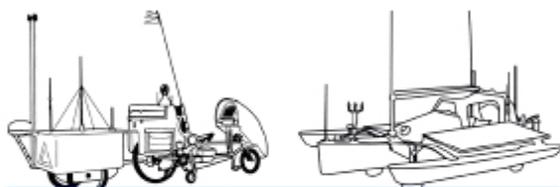
Thank you for being part of this, and for helping keep *Nomadness* afloat!

-- Steve



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Applied technomadics since 1983
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THE FACILITIES QUEST

An Impractical Commute

The Nomadness project has been hobbled for over 3 years by an absurd lack of workspace convenience. This may sound a little like whining, coming from a guy with a 3000 square-foot building in the woods, but when said woods are on an island with no moorage, we have a problem.

I bought the boat in October 2007 and managed to make reasonable progress on the initial, most-urgent items... both at the dock and underway during a 621-mile [shakedown cruise](#) in 2008. But then I was ready to turn my attention to the big project, and secured moorage in Oak Harbor with the intent of getting to work. It was close to home as the crow flies, but when the crow had to drive a diesel pickup truck 2 hours each way between boat and lab, progress slowed dramatically. "Damn, I forgot the bifurcated widgetframus! Oh well, next week..."

Things continued in this vein for another year, the to-do list growing. expensive gizmology depreciating in boxes, a sense of futility creeping in. Was I being realistic? As another winter settled over Puget Sound, the boat mostly just sat.

I began to realize that the only way out of this would be to find a way to bring living/working space into mutual proximity with boat parking. How hard could that be in Puget Sound? But a few months of house-hunting proved it to be VERY hard, and again very little sailing (or boat work) got done.

It became clear that I needed to decouple myself from the dusty old Microship lab in the forest, and that led to the long but ultimately worthwhile *Polaris* project that [began](#) in the Spring of 2009.



Adding a bit of extra seating in the cabin

The conversion of the saloon to a lab is eliminating the traditional dinette, so adding places to perch was a priority. I drilled blind holes in the companionway rails, and mounted a pair of stainless [spring latches](#) on a piece of plywood. With a little upholstery work (using a pneumatic stapler and left-over supplies from a previous project), I ended up with a convenient step-seat that can be quickly attached at any of four locations... from kid-level to catbird. Those latches are the key, and the price is right since they're not called "marine spring latches"!



Conjuring a Mobile Lab

There's a thorough [four-part series](#) in *Make:Online* about this rolling workspace, as well as a few posts in the [Nomadness blog](#)... so I won't go into detail here. But basically, this 24-foot trailer is a distillation of the big lab into a very tight and efficient portable workspace that I can tow behind my truck... and this is hugely liberating.

So by early 2010, the problem changed: if I could find a place to live aboard with *Polaris* parked nearby, I could get on with the project. I tried relocating to Olympia, but the marina was intolerable and the logistics never added up (though I did manage a substantial [haul-out](#) and bottom-job while there). On the cusp of looming relationship change, I moved *Nomadness* north to Everett... about as inconvenient as Oak Harbor, but twice the cost and less congenial. OK, this is getting ridiculous. What to do? Go broke with all the expenses and then sell the boat, dreams unfulfilled? No.

THE FACILITIES QUEST

Enter La Conner

When Everett started waffling on the promised space for the mobile lab, I went on an urgent quest... and a Craigslist post yielded the answer. A dock on the Swinomish Channel, a retail/office space, and inside parking for the mobile lab... all in a friendly town with considerable boat traffic and a deluge of visitors drawn by tulips, art, and the



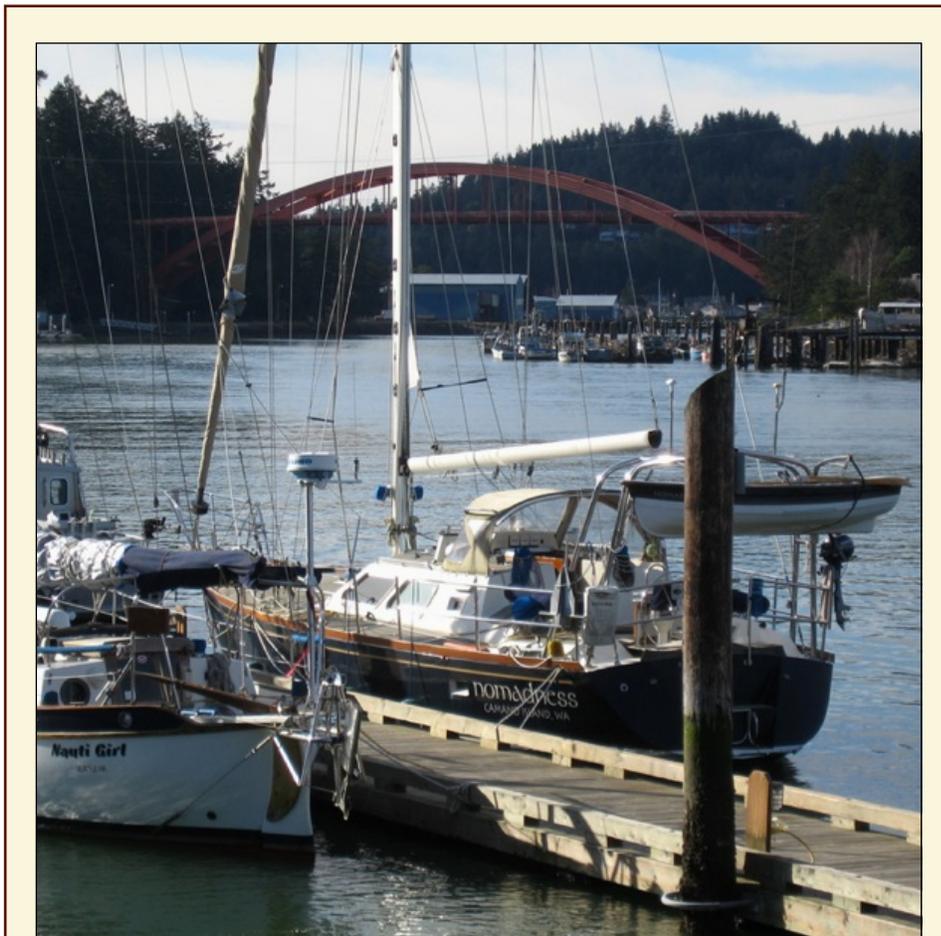
upcoming [Paddle to Swinomish](#) at the reservation across the Channel at the end of July.

But the best part? Mobile lab, public staging area, and boat... all are within about 2 city blocks. Messy work happens in *Polaris*, systems get integrated and brought online in the "gallery," then everything all gets installed into the boat when ready.

Geek Performance Art?

It's a little bizarre, but I have a long history of this sort of thing (though usually in a more tech-culture setting like Silicon Valley).

It will be an interesting experiment to see how I can handle project immersion behind a glass storefront between a winery and scone shop. "Look, honey! The traveling circuits is in town!"



The New Staging Area

Here is the Nomadness-development scene in La Conner. The dock above is right at the end of the main drag in town, a place crawling with tourists during tulip season. At the right are the two associated facilities: a 300 square-foot retail space, and a funkier inside parking garage for the Polaris mobile lab that has a bit of extra space for messy jobs. All are within a few minutes' walk of each other, and life aboard the boat is a lively scene with Swinomish Channel traffic just out the window.



LIFESTYLE UPDATES

Water Heater

When I bought the boat, it came with a Bosch demand propane water heater with standing pilot...

something that is illegal according to ABYC standards and definitely not insurable. Besides, it had been installed badly and didn't draft well; taking a shower resulted in combustion products (CO and water vapor) all over the cabin. I pulled it out and sold it on eBay to a fellow in Reno (fine for land use).

When dealing with the Plumber-from-Hell on the 2008 holding tank installation, I bought an Isotemp Slim Square 4.2 gallon unit, which (like so many other things during the facilities ordeal) sat idle for over 2 years. I finally installed it last week, in a little cabinet behind the wall of the shower compartment.

The unit is interesting in that it has a 115 volt AC heating element in addition to a heat exchanger that's intended to be inserted in the boat's engine cooling loop. The former scales well to *Nomadness*, but the latter scares me... a failure there would be catastrophic. So my plan is to build a solar collector atop the dodger (once it's redone in stainless), and run a tiny gear pump to push the working fluid down into the boat and through this coil. I haven't seen anyone try this, but there's no reason why it wouldn't work.



Installation involved the usual fixturing, as well as more-than-the-usual confusion with plumbing fittings. The manufacturer uses BSP (British) threads on the mixing valve, and NPT (US) threads on the rest... at least, I think so. Their documentation is annoyingly vague, and since the fittings appear to interoperate but won't hold pressure if mixed, it's not easy to figure out. But after much head-banging, it seems to work... and

I've now had 2 delightful hot showers aboard (about \$350 each, if I recall the purchase price correctly). Now I can proceed to amortize this investment, and be less frustrated by the biological components of staying aboard for 3-4 days at a time!

Curtains

This is one of those things that doesn't sound like a big deal... but remember my comments about the tourists on the previous page? *Nomadness* feels like a fishbowl in any marina, given all the pilothouse windows, but I feel even more naked when the general public is walking around and taking pictures of the pretty sailboats from shore.

Years ago, my fabrics-guru friend Karen made curtains for the three steeply angled forward windows. A rich blue Jacquard fabric faces inside, and UV-resistant Solarplex faces out. Because of the sag problem that would normally require complex tracks or annoying Velcro, we used high-power N52 neodymium magnets — one at each attachment point bonded to the window frame with adhesive foam tape, the other sewn into the curtain.

This has worked well, so now the four side windows have received similar treatment. My partner Kirsten has done a beautiful job sewing them, with the magnets tightly hand-stitched just inside the outer seam of the fabric sandwich. Working from the Camano Island home base, she'll be offering Kirsten's Curtains as a product, complete with mounting kits, based on customer-provided templates.

Now I don't have to "suck it in" when galumphing through the cabin at night...

Adjustable Bed

All this "lifestyle stuff" sounds boring compared to a distributed network of Arduino-based nodes talking to an always-on Linux server, but a boat is a complete life-support system. Keeping bodies working is just as important as the gizmology.

This is going to be no ordinary berth. I have some nasty back problems (spinal stenosis) and sleep is painful if I'm stuck on even the cushiest of flat beds. At the home base, I use a pair of remote-control [S-Cape](#) adjustable beds from Leggett & Platt, with latex mattresses (that's a lot o' bunk!). But what to do on the boat?

This is a work in progress, but basically I reverse-engineered the home bed to find the hinge points, factored in mattress thickness, and cut plywood panels shaped to fit the VEE berth in the forward cabin. (I've moved from the king-size oppressive cave at the stern to the bright but compact PENFA suite... so named because the Pointy End's Not Far Away.)

Anyway, these are articulated with [polyolefin hinges](#) from McMaster-Carr, much cheaper than stainless (about \$3.50) and fine for the application. Since there's no room for fancy motors, I considered hydraulics but settled on something more in the sailing context: standard blocks and cleats. I'll have two control lines on the bulkhead, one for the top half o' me, and the other for the knee segment.

A *Froli* sleep system might be added below the existing mattresses, but that can be decided later. My only concern is the cat, Isabelle, who may decide the magic cave is a perfect place to sleep... then be crushed in the middle of the night when I decide to roll over.

COMING UP

Infrastructure Projects

There are quite a few ship systems that are about to receive serious attention:

- A new AC and DC power console, including a bottom-hinged panel to replace the one that currently makes service painful. This includes about 50 circuit breakers, power monitoring displays, generator controls, and the user interface for the [Outback](#) inverter/charger and solar charge controller.
- Waterworks, which will pretty well fill the forward wall of the aft head compartment and bring all fresh-water processing into one region. This includes a [Katadyn 40E](#) desalinator, ultraviolet & carbon filter system, and all the valves for routing among shore water, port and starboard tanks, and distribution. This gets a node, which uses a flowmeter and valve-position sensors to track usage, tank levels, filter media life, TDS, and so on.
- Sewage upgrades, including elimination of the cruddy old Lectrasan that came with the boat and additional repairs to the problems introduced by the Plumber from Hell (a botched Spinweld, sheet-metal screws instead of bolts bulging the access panel in poly holding tank, and hose leaks).
- Solar array integrated with the arch, including support for enclosed cockpit fabric.

- Redneck Bow Thruster, which is essential. Cap Sante Marine quoted me \$13K for installation of a Lewmar tunnel thruster, but I think I can meet its performance with a more flexible system for about \$3K. The boat desperately needs something, as there is about 11 feet between the 3-blade Max-Prop at the trailing edge of the modified fin keel and the leading edge of the skeg-hung rudder. No prop-walk and a lot of windage translates into scary close-in maneuvering, and I don't want docking to involve insurance companies.

Console System

Of course, the part of this that most pushes my geek buttons is the lab... which will occupy an 8-foot segment of the boat just forward of the raised-salon pilothouse. A desk will fill the original dinette region, with a wrap-around sloping console of four panels. These are loosely grouped into computer systems, communications, audio-visual production, and lab.

Folding table wings at the ends will allow this to be a pretty immersive environment wrapped around a swivel chair, and a hinged panel on the desktop will open to reveal a full-size digital piano (my existing Roland RD-700SX). The console includes a mixer and tools for podcasting and annotating videos.

Until the La Conner situation materialized, I figured I would do all this in place, with the components assembled piecemeal in the mobile

lab. But this would have been physically awkward, rendering life aboard intolerable for months.

The immediate project this week, then, is to build a laminated 4x8 work table in the public space, which will serve as a development facility for at least the next year. I'll build the console systems here, then carry the whole mess aboard when it's time to cable it up.

Stay tuned!

Thanks for coming aboard...

It's a real pleasure to get back to this mode of publishing. With the [blog](#), I have been waiting too long to do each post, wanting each to be tidy and complete. But a massive project isn't like that; the real story is this one, an ongoing sloppy and challenging adventure. That's what's going to fill the pages of the Nomadness Report, and your subscriptions are helping to keep things moving.

Cheers!

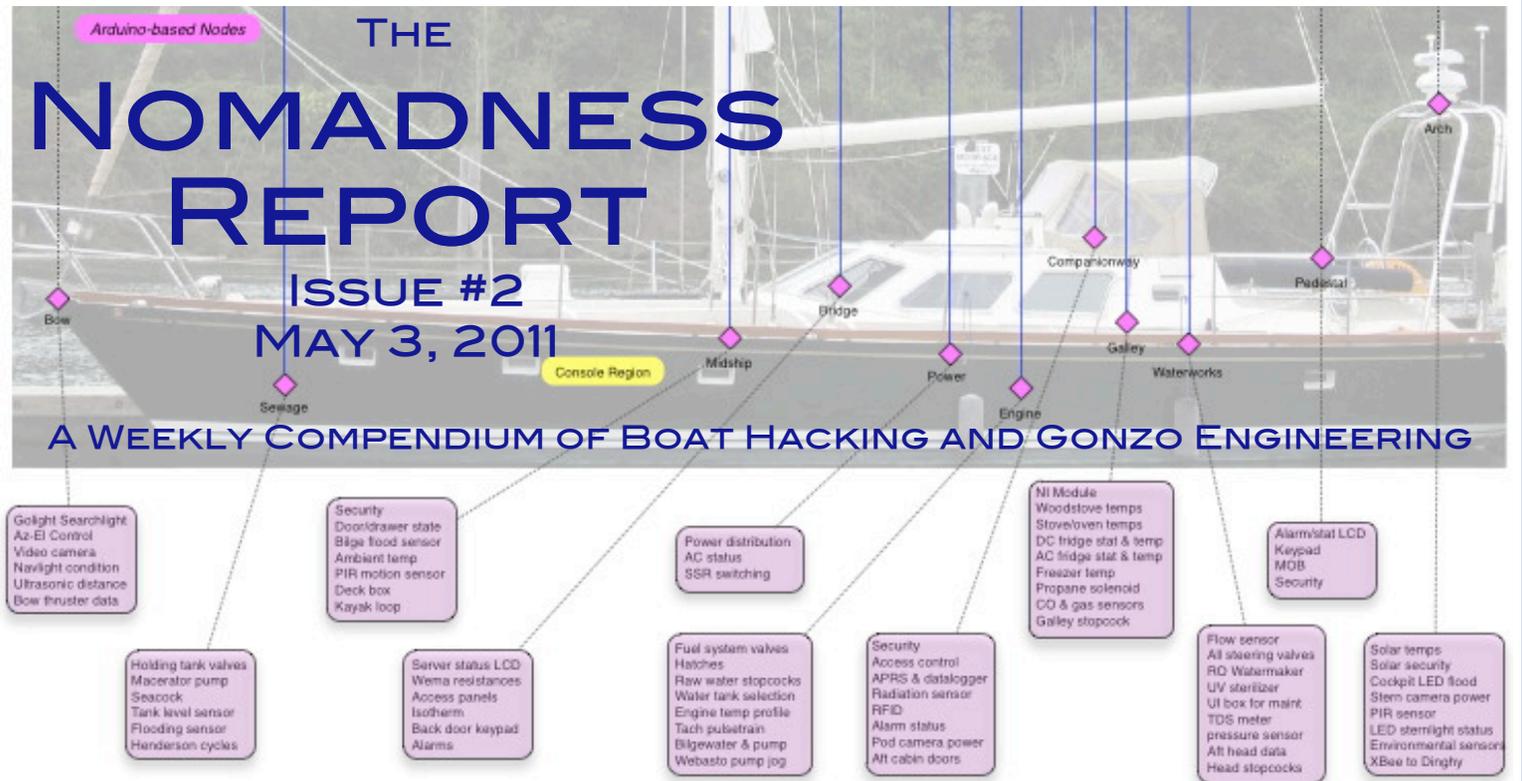
-Steve



THE NOMADNESS REPORT

ISSUE #2
MAY 3, 2011

A WEEKLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



Welcome to the second issue of the *Nomadness Report*, and thanks for subscribing! In the few days that have passed since the first issue, I've had a chance to further clarify my thinking on what separates this from the blog and other publications.

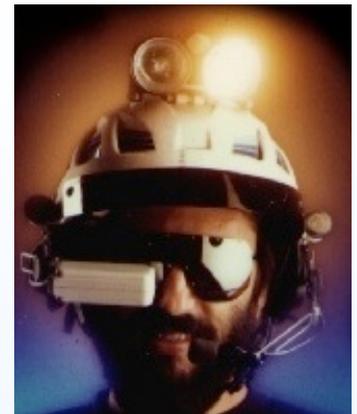
Basically, this is higher value technical information than the blog. Although I do have long-term plans to publish a collection of *design packages* with associated kits, I know how daunting that sort of thing can be when I'm also living the project (or sailing... there's a concept!). Rather than wait for a time when I can produce and market the books, I've decided to put that class of content right here while it's fresh (though the design packages will eventually include schematics and software listings for those who want to dive in).

On the assumption that most of my subscribers have strong technical interest in various aspects of this project, I'll make this my most substantial publication... the blog will continue to be the public face, focusing on overviews, tales of adventure, and the transition aboard. Meanwhile, this will carry hacks, design details, geek humor, and the whole twisted gonzo-engineering narrative.

I'll also take reader questions here, and might make that a weekly feature if there is enough interest.

Please tell your nautical, geek, and technomadic friends about this... if I can get a steady 1-2 new subscribers a day then it will reach critical mass in project funding (covering moorage and lab expenses). Thanks for helping keep *Nomadness* afloat!

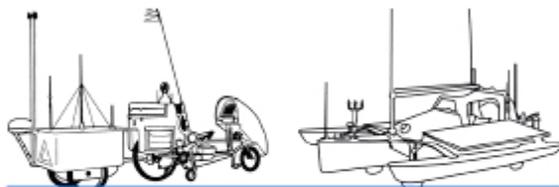
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I feel light-headed!

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MEET SHACKTOPUS

Historical Perspective

The idea of incorporating diverse devices into a single user interface actually goes back to my *BEHEMOTH* bicycle, circa 1990. After 16,000 miles on two previous versions, both architecturally inflexible, I wanted to build a system that could push all my geek buttons with a minimum of wheel-reinvention.

This meant that everything had to interoperate, no matter what company built it or what "standards" might be involved. I would acquire a widget, strip it of plastics and power supplies, find the *hooks*, and integrate it into a system so it could share serial, audio, or other data with its neighbors.

A key component here was the crossbar network, which grew [more robust](#) in the Microship project that followed. Using the Mitel 8816 crosspoint switch and some FORTH code, we built boards that could let anything talk to anything. Want a security event to trigger a call to the cops? Just turn on the speech board, connect its serial port to the bicycle control processor, route its audio to the cellular interface, transmit a string to the phone, and watch the fun!

That was 20 years ago and the [bike](#) is now in the Computer History Museum along with my first [homebrew computer](#), but we still have exactly the same problem despite vastly better communications. In general, stand-alone devices are available for a huge range of applications, but do not come with associated software objects that can live in a browser. This is unfortunate, and is why I have to build Shacktopus.

I coined that name in 2005 with the intent of creating a sort of "abstracted" communication and data-collection laptop. But the project was aborted due to a death in the family, and besides, now we have smart phones and don't really need to do it anymore.



Brion Toss Gives the Rig a Once-Over

During the 2008 shakedown cruise, we welcomed a wizard aboard... [Brion Toss](#), author of [The Rigger's Apprentice](#) and other excellent references. He had lots of useful advice, and generally gave the rig his imprimatur... but for one detail. A link plate on the jib furler, with no toggle, was "looking very tired." It was the wrong part anyway, with very little thread engagement to the turnbuckle. When asked when I should fix it, he said, "before you put the sails up again!" [We did](#).



Starship Enterprise on a Sailboat

It's been a long time since I was that grinning fellow on the left there, but I have the same crazy desires. I want to blend all my passions into a technomadic lifestyle, and if I don't pay attention to system integration, that will translate into a huge mess. Data collection from inside and outside the ship, monitoring plumbing and fuel flow, power management, coordinating communications, creating a context for piano playing and podcasting, integrating existing navigation tools, dealing with a dozen video channels, remote controlling almost everything from ashore or afar, networking with the technomadic flotilla, having a robust security system, continuing R&D projects, streaming telemetry to public servers, probing the environment... this is going to take more than a bunch of commercial boxes stashed wherever they fit!

Much of the discussion in this publication is going to be about how we bring this all into one cohesive system.

MEET SHACKTOPUS

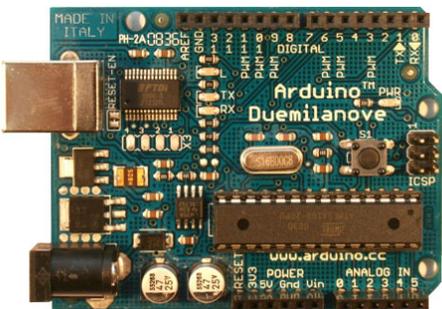
Big Picture

Basically, what this requires is a central always-on server that presents the boat's "website" to a local wireless device or any authenticated browser out on the Net... while also providing back-door interfaces via voice I/O and packet radio. This machine maintains a database of points, steadily polling about 15 nodes scattered around the boat (those are the little purple diamonds on the title background image on this PDF).

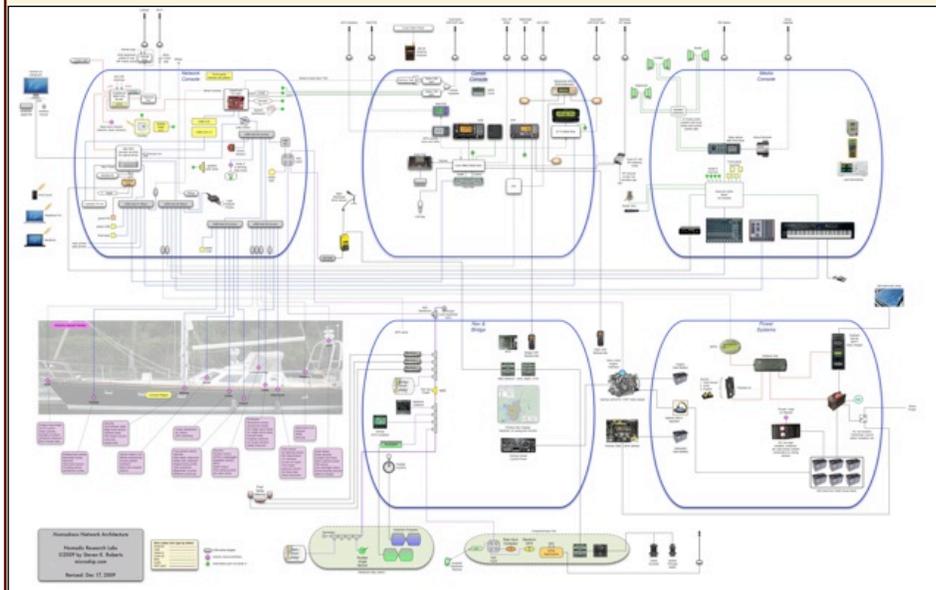
The nodes are based, for the most part, on the open-source Arduino microprocessor... readily available and cheap, with a very friendly support culture. There are so many people hacking with these now that just about any flavor of I/O can be found off the shelf as "shields," little daughter boards that plug onto the SIP connectors you can see in the photo below.

As this project develops, much of what I'll be writing in these reports will be about the nodes... each associated with some broad swath of ship operations. In many cases, these do not do any local control, but simply gather system state to allow meaningful graphic displays. Example: 3 diesel tanks and 2 Racor filters makes for 18 possible relationships of source/return/filter. A live block diagram with bright or grayed-out lines will let me see at a glance what's happening with fuel flow.

And speaking of fuel...



The Mega-drawing



There is a poster-sized drawing on the wall of my lab (6 sheets of paper), representing the whole ship system as currently conceived. Here are the regions, from upper-left to lower-right:

1. *Computers and networking, with the Linux board, Mac Mini, USB hierarchy, speech I/O, data-type-agnostic crossbar matrix, and so on.*
2. *Communications, including ham radio, datacomm, APRS, and back door.*
3. *Audio, with the piano and mixer as well as stereo and distribution tools.*
4. *An orthogonal view of the boat showing the Arduino nodes, all of which talk USB (or XBee, if too far away) back to the system console.*
5. *Navigation and ship operations, based on standard NMEA 2000 tools... with associated subgroups like autopilot and outside helm console. This separate network has a gateway to my own server so all the ship sensors are available.*
6. *Power management, including Outback inverter-charger and solar controller with its own monitoring system... also streaming into the ship server.*

I don't yet know the total number of data points (both "real" and "derived"), but it's over 250. Each of these is added regularly to a back-end database, with time stamps... making it possible to generate historical plots for any measurement or correlate anomalous events to assist in fault detection.

FUEL MONITORING WITH NMEA2000

Meet Jeb

I'm sure I don't have to work to convince you that having a way to monitor the fuel in your boat's tanks is a Good Thing... suddenly running out can turn a fun day on the water into an unwelcome lee shore adventure. If you're burning diesel, it's important to avoid sucking air, as it will then be necessary to bleed the system.

Even without considering emergencies, you probably want more than a gross approximation of the amount remaining in your tanks. This data is essential to develop a fuel

curve for the vessel, allowing you to find the most efficient cruising speed and increase the accuracy of range predictions in varying conditions (though you'll get better data by directly

measuring consumption).

Before getting into our tank monitoring system, I have to share a little tale from the 1970s. I had a small business in Louisville, and paid a fellow to come around every couple of weeks and do the grown-up accounting stuff that mystified me. Tom had many other clients, one of which was a coal company in Eastern Kentucky.

He showed up one day, laughing, and told me of his recent visit to the hills. The owner had told him that he reckoned someone was stealing diesel fuel from the tank at the barge dock, since there had been some wild fluctuations in its reported level. He was hoping that Tom could figure out the numbers and help find the culprit.

Looking over the purchase and consumption records was making no sense, so Tom decided to begin at the beginning, as they say. He made his way down to the dock and found the attendant, a lanky fellow named Jeb.

"Morning," he said. "We're having trouble figuring out how much diesel is being used... can you show me how you measure it?"

"Yessir, I sure can." He picked up a long stick, printed with numbered tick marks. "You see this here stick? I just put 'er all the way down in the tank, like this... and then when I pull 'er back out, I look at where it's wet, ya see? I write that number on the clipboard and take it up to the office."

Tom peered at the stick. "Which end do you put in the tank first?"

"Shee-it, I dunno!"

We can do better.

Manual Methods

Actually, there's nothing intrinsically wrong with a stick... my ex's Cal 2-29 with one-lung Farymann diesel uses this method, and it works fine (she even named the stick "Jeb"). With careful record-keeping, attention to which end goes in first, and basic hygiene, this may be all that's needed.

One step up from the stick is the venerable sight glass: a piece of clear tubing mounted vertically on the outside of the tank, plumbed into it at both ends. It doesn't get much simpler than this, and if your tanks are conveniently located and you don't care about remote monitoring, it's a time-tested and perfectly acceptable method.

I've known people who take a third approach, and have managed to fine-tune it to remarkable accuracy. With careful observation and record-keeping, one can monitor the running time of an engine (especially if it's kept at a constant cruise RPM) and apply a simple gallons-per-hour formula to determine how much has been used. This requires accurate knowledge of the engine's fuel curve, along with an understanding of how that varies with hull/prop fouling and sea state.

You can implement a much more refined version of that with accurate flow monitoring using readily available instruments (see [Floscan](#)). This is analogous to battery

monitoring technology... by recording the exact amount used and paying attention to consistent fill levels, you can always figure out how much you have left. But this can get out of synch with reality if you have multiple consumers, like a diesel heater and genset, or if you are switching among multiple tanks and not taking careful notes.

In the case of *Nomadness*, there are three tanks: one of about 90 gallons under the berth in the aft cabin, and two "wing tanks" of about 70 each that are hard to reach beneath galley and pilothouse furniture.

Out with the Old...

The boat came with a rather clunky system, with an analog gauge on the instrument panel. This was an old, inaccurate meter reminiscent of a 1957 Chevy, and was made worse by the tank-selection protocol: mash one of three heavy chrome buttons to connect the associated swing-arm tank sender to the meter, displaying the fuel level:



These old senders are evil things - basically just wire-wound rheostats (33-240Ω range) with a sliding wiper attached to a float on a swing arm. They are famous for failing, as mine had, with the measurement being so random that I longed to get Jeb involved. That wasn't possible, of course, due to the locations of the tanks.

FUEL MONITORING WITH NMEA2000

Wema Sensors

After considerable research, I decided that the new sensors should be from [Wema](#). Mine are the [SSS/SSL](#) series, which have the same resistance range as the old standard but operate, magically, with a floating collar that glides loosely up and down a 316 stainless column. I played Jeb a few times to get accurate measurement of my tank depths, then placed the order.

They're quite beautiful, industrial-strength devices, and were not difficult to install. My wing tanks already had aluminum inspection ports, and drilling the center hole and bolt circle was a quick drill-press job. The aft tank already had the same industry-standard hole pattern, and merely involved some cleanup, re-tapping,



built electrically atop CANbus. I had already installed a backbone for the autopilot and other nav goodness, so the obvious plan here was to get the Wema sensors on the bus.

[Maretron](#) makes a wonderful

(though not particularly cheap) line of NMEA 2000 devices, and their [TLA100](#) is designed to convert any standard resistive sender to a stream of events that allow one to see fuel levels on any display aboard the ship. In the long run, *Nomadness* will have her N2K data bridged to an always-on server that will allow seeing it all in a browser environment, but at the moment I just

removal of old form-a-gasket, and a couple of attempts to get it sealed (re-doing old stuff is **always** harder than new stuff!).

Maretron TLA-100 Interfaces

OK, so now we have the raw analog data source... how does it make it to a display? The new marine networking standard is NMEA 2000 (or N2K in boatnerdspeak), which is

have a single DSM250 from Maretron at the inside helm.

The TLA100 is configurable, of course; from the display, you can associate each one with a tank number, set capacity, specify gauge resistance, tweak the calibration, or even define a bunch of data points while filling to map the values onto an odd-shaped tank. I should do this,

but am always too stressed while at the fuel dock...

Anyway, in the middle photo you can see one of my three TLA100s plugged into the bus behind the helm console.

Virtual Gauges

Now that fuel data is streaming onto the N2K backbone, what do we do with it? This depends quite a bit on the available display, and in some cases it might be just a numerical value... or a window in a multifunction chartplotter display at the helm.

In my case, the excellent Maretron [DSM250](#) provided an opportunity to put all three tanks logically on one screen. The largest tank is aft (at the bottom); port and starboard wing tanks are slightly smaller (top). At a glance, I can get a good sense of my fuel situation:



Would I do this again, in retrospect? Probably yes, given interoperability with other equipment including a display at the outside helm. But the Bluesea [Vessel Systems Monitor](#) (on Amazon [here](#)) is much cheaper and, while not graphically "modern" looking, can present an amazing amount of information (including three tanks). Ahhh, so many ways to spend boat bucks!

A WORD ON COMPLEXITY

A Layer of Abstraction

I have often, not surprisingly, had to endure criticism from people who feel that I am over-complicating things. This goes all the way back to the bike epoch, when every few months in the midst of all the fan mail there would be a hostile letter with comments like: "you are bastardizing the simple, beautiful act of bicycling."

These days, such criticism is more likely to come from sailing purists, for indeed there is a very well-known phenomenon on boats: **complicated stuff breaks**. Just ask any long-distance voyager about their refrigeration system.

I do find some of those comments ironic, though... with the exception of pure traditional wooden-boat sailing, almost everyone on the water these days is carrying a fairly substantial collection of high-tech tools: internet access, smart phones, radar, GPS chartplotters, sonar, weather sensors, satellite radio, TV, MP3 player, sine wave inverter/chargers, solar panels, and engine monitoring systems. When such folks look at my gizmological overlays and call them "too complicated," I do have to chuckle a bit.

The whole point here is a *reduction* of complexity... at least from the perspective of day-to-day operation. If instead all this stuff adds to the confusion and creates *more* maintenance headaches, then I will have failed.

The real point of this project is to achieve the sort of smooth layering of technology that was well depicted

(fictionally) in the Start Trek *Next Generation* series. Huge sensor arrays and complex systems were reduced to voice interaction and clear graphics, and the whole operation was paperless. The underlying complexity did not go away; it just didn't nag the user with the need to be cognizant of every little detail. Like my fuel example earlier, something as trivial as a few magnetic reed switches on the tailpieces of rarely seen valves down in the engine room translates into a clear vision of what's going on in real time.

The key point here is that I am not handing over control to a bunch of microprocessors... at least, not where anything critical is involved. I would never trust a network of computers enough to make it my *only* way to turn on the navigation lights, for example, but if I throw the toggle switch on the power console and a synthesized voice informs me that the stern light is not drawing current, then the machines are doing their job. If integration of water flow causes a counter in an Arduino to roll over 5000 gallons, prompting it to send a flag to a database-backed server that then includes a service advisory in my morning report, then I will have created a useful work-around for my own inadequacy regarding preventive maintenance.

The Importance of Passion

But there's a less-pragmatic component to this, and to be honest, that's what truly drives me. This is not just a toolset, but a way to fold all my technopassions into a single

immersive lifestyle. Fellow geeks totally get this, but traditionalists look at all the projects and go, "whaaaa, dude, are you nuts?"

As I wrote in my [Gonzo Engineering](#) essay, "our motives are usually as guileless as passion itself: chasing daydreams, building tools, realizing obsessions, shattering limits, publishing, earning grins of appreciation from the cognoscenti and accolades from neophytes." In other words, it's fun.

There's nothing radical about combining one's interests with travel; mine just happen to be übergeeky. The sailor who paints the scenery while anchored in a beautiful cove is pushing exactly the same set of buttons.

Here we go...

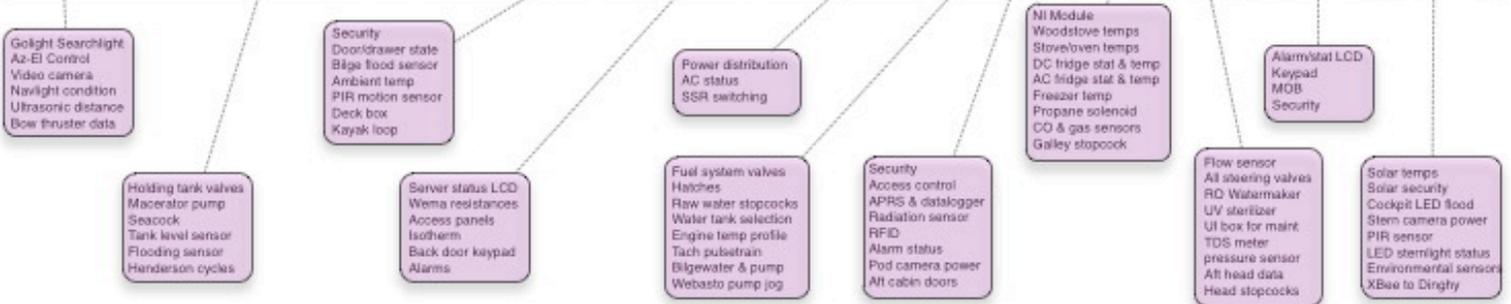
With this issue, we have moved beyond the initial introduction and set the stage for tracking the unfolding details of this crazy project. The plan is to pause every 12 issues and produce a printed compilation, and use the cash flow from both to keep the project afloat.

Thank you for being a part of it!

*Cheers and fair winds,
Steve*



nomadness
CAMANO ISLAND, WA



SPECIAL ISSUE: THE SHIP NETWORK

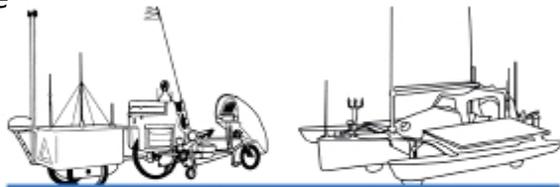
Our brief introduction to *Shacktopus* last week set the stage for something more substantial. We have discussed why it might be interesting to scatter data-collection nodes around a sailboat... but how do we intend to do it? And what do all those nodes (the pink diamonds in the image above) actually *do*? This issue is devoted to this sprawling system.

We have a few other special issues coming up, including one on GPS tracking tools, one on the mobile lab that let me deploy a robust development facility close to the boat, and another on amateur radio applications aboard. Meanwhile, the projects are underway... we're not going to run out of material!

I'm gratified by the response to this publication so far, and have plans for some very diverse content... including a "Subscriber of the Week" photo/caption since this attracts people who have interesting stories to tell. If you'd like to be featured (with a link to your site), please [let me know](#).

Oh, that 20-year-old photo of me at the right, like the one on Issue #2, shows the [Brain Interface Unit](#) that was part of the *BEHEMOTH* bicycle.

-- Steve



Nomadic Research Labs

Applied technomadics since 1983
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SHACKTOPUS OVERVIEW

Introduction

Last week's brief discussion mentioned bringing diverse objects under the umbrella of a single user interface, then described the architecture as a central database and a collection of nodes. I even included a rather unreadable mini version of the architecture drawing just to convey a sense of scale.

Armed with that, we can look more closely at how this is intended to be used... and why it's relevant. My intent is for this issue of *The Nomadness Report* to provide a broad understanding of this system; future issues will be much more focused on individual components, and will refer back to this for context.

Only a small part of all this is dedicated to direct control of the boat systems; from a seamanship perspective, one might question the wisdom of adding potentially fragile layers to systems that need to be highly reliable. Indeed, most safety-critical systems operate entirely independently of *Shacktopus*: I throw a switch to turn on navigation lights, turn a knob to select VHF channel 16, and pull strings to control the sails.

But that's not what this is about. A modern voyaging vessel is an insanely complex collection of systems, including engines, plumbing, power, comms, and more. Unless one obsessively stays on top of everything (impractical), on-board "situation awareness" can easily drift out of synch with reality. Important procedures are forgotten, maintenance intervals slide, and issues can develop that have serious implications. This has happened to me many times.

My solution calls for a suite of sensors, a historical database that logs channels at appropriate intervals, and a few software tools to wrap it all in a layer of abstraction.



RopeTie: Instant Trucker's Hitch

This is one of those "why didn't I think of that?" items... making it easy to fixture a line under tension. Available from [Hitchcraft](#), these come in two sizes, and consist of a horn cleat and jam cleat (plus a little post to keep the line fully wrapped on the latter and an eye to keep it tethered). A loop through the horn fixes it to the standing part, and the bitter end is taken around whatever you're trying to tension and cleated off. Quick and effective... I use two of these to hold my dinghy on the davits, then cinch it with a pair of stainless ratchet straps. The alternative all-line approach is more universal, but much harder to do on-the-fly.



- Is the diesel fuel in the starboard tank below the sip tube for the Webasto heater?
- Does the temperature profile across the main engine heat exchanger suggest a blockage that may indicate impeller failure?
- Is one of the solar panels giving less and less output as time goes on, suggesting water incursion or other slow failure?
- Is my anchor light drawing current when I turn it on?
- Has the bilge pump cycled in my absence?
- Can we fine-tune mental "polars" on the boat by observing true wind, accelerometer data, and autopilot performance?
- Is someone trying to pump the holding tank without opening the vent stopcock, setting the stage for a poop implosion?
- Are there any anomalies in the sensor array that warrant a stop at the nearest starbase?
- Do filters need changing?
- Are there phantom loads increasing quiescent current?

SHACKTOPUS OVERVIEW

I could go on and on. I want to know these things when aboard, be notified of developing problems, and feel secure in the knowledge that a tireless watchman is keeping an eye on security and systems. I want a full-system control/monitoring interface at my fingertips, on or off the boat. I want to be walking on shore, and even without Internet connectivity be able to transmit a status request via waterproof ham-radio hand-held rig and get a spoken response.

If designed wisely, this will scale well. Some interfaces are standardized (NMEA2000); others, like an array of valves, require proximity sensors and a local microprocessor. Coupled with the more active tasks (resource and configuration management with a crossbar switch matrix, power control with solid-state relays, direct involvement in networking and radio communications), the obvious toolset is an I/O rich, power-efficient server and a distributed network of microcontrollers.

The system architecture is significantly shaped by a few tools. The always-on machine will probably be an embedded Linux single-board computer, though all development is taking place in a Mac Mini... and frankly, I'd be happiest leaving that in place down the road even if there is an extra power cost. It's just easier.

The front-end software will be implemented in [DataPrism](#), a very cool (and yet little-known) system that allows active objects to run in a browser. The associated SQL database can also be used to archive hundreds of data points and events, which is a key requirement. We will also need a few autonomous programs to take care of security, watch functions, alarm monitoring, and an interactive "back door" that includes both DTMF/voice and packet datacomm via ham radio... allowing access from a waterproof UHF rig or minimal computing hardware.

Of course, Macs don't have ports for all the sensors... so interconnection with the boat is a mix of USB I/O modules, sources that continuously feed data from other systems (NMEA2000, Outback power, and Carnetix), and about a dozen Arduino nodes scattered from bow to stern.

Let's elaborate on the server software, then look at those nodes a little more closely... that's where a lot of the fun will be.

Microship Flashback: The Video Turret

Speaking of nautical gizmology, this device was the result of over a man-year of work during the Microship project in the mid-1990s... and the [complete design](#) (including schematics and FORTH listings) is on my website. We used a 68HC11 board to steer a video camera in a sealed, pressurized enclosure... with UI tools written for a wireless Newton. I still have the machine here in the lab, but now that video cameras are cheap, it's overkill... and may be repurposed to keep a WiFi beam aimed at a shoreside access point while I swing at anchor. Along with audio, video, and serial crossbars, this was one of the most successful student projects when I was teaching at UCSD. (The lead programmer, Nathan Parker, is now a senior software guy at Google.)



PRIMARY SERVER TASKS

DataPrism

Basically, this is a database-backed server that connects physical (or virtual) devices to corresponding live objects on a web

page, giving us a dynamic set of tools for interacting with the boat. Without it, we would be limited to HTML page-refreshing augmented by various kluges for animation within sandboxes (assuming that we wish to keep the user

interface in a browser, which is desirable for lots of reasons including the use of off-the-shelf smart phones, iPads, and remote laptops).

[DataPrism](#) is described as "A visual, object-oriented application platform for authoring and deploying rich networked solutions in web browsers, locally and through the cloud." This translates into something very smooth and beautiful, feeling more like a dedicated application than pages you'd find at a website. It plays nice with Perl and other standard development tools, so stitching it together with the rest of the system should not bog us down in epic software projects.

Datawake

An important information source in the system is historical, and we thus need to selectively database many of the sensor channels. The challenge is that some need high sampling rate and some low; others are only interesting as events; still others may be annotations or other data that doesn't even have a hardware counterpart.

All this calls for a flexible system (with metadata) for stuffing time-stamped entries into a database that is then accessible to DataPrism (as when observing historical solar panel performance or trying to debug an engine issue by looking at the last few dozen hours of logged temperatures and RPM). The

Datawake term stems from my earlier project that postulated a wake of data streaming behind the boat, and it has environmental monitoring



components that make it interesting to others (indeed, this led to a contract with the National Science Foundation a few years ago to produce a field data collection system called [WANDER](#) - a project I shared with [Ned Konz](#) and [Tim Nolan](#)).

A filter will be in place that allows a lower-resolution version to be mirrored on a public server as part of our expedition web presence.

Back Door

In addition to the browser-centric user interface, the system has two methods for handling queries. The first and easiest is a simple text interface over a serial port, using packet radio via a dedicated 2-meter transceiver and TNC.

The second is highly useful, and takes a few forms. The output is a V-stamp speech synthesizer, which is steered via audio crossbar to a UHF transmitter, local audio in the cabin, cellular phone, recording interface, loud hailer, or whatever. The input is nominally a DTMF decoder that receives Touch-tone transmissions from a small UHF ham radio, but this same alphanumeric "instruction set" is accessible via keypads on the boat (or at least one in the console, next to the server board). This allows simple commands with voice response when conditions don't permit the luxury of a browser (or exposing delicate electronics), and it can also work via telephone using the

boat's embedded cell number. This will make it easy to check for alarms, request summary of any subset of data points (power, security, weather,

etc), enable remote-control functions (turn on spreader and cockpit lights), do a demo for the media as I did with the bike speech system, etc. Given this functionality, it's a small leap to automated emergency transmissions with sufficient interlocks. I've already written a

basic command language for this, and it may be one of the first tools to come online once the server goes live.

Dog Watch

This is a loose name for a subsystem that is used for security monitoring and general watch operations... staying alert for error conditions (excess woodstove stack temp), human oversight (propane solenoid still on after stove is off), safety sensors (CO/smoke/fire/propane), and the security system (perimeter and PIR sensors). Given the changing parameters and relevance of sensor data in different situations, it will take the form of an editable matrix. All the current sensor data is present in a data structure, so this looks at that, applies a few tests, then either logs an event or takes some kind of specified action based on current activity (local voice annunciation, indicator lights, displays, radio transmissions, email, voicemail, text messaging, alarm sounds, etc).

Utility

Of course, this always-on machine will also provide the basic computing toolset that we've come to expect to have at hand aboard ship: email, web browsing, documentation archive, databases, navigation, music, and so on.

STREAMS AND NODES

At its heart, this whole system is about the relationship between a very diverse range of data and the humans who live with it. As such, a huge part of the development will be focused on data collection, with the current snapshot of the entire *Nomadness* environment always available as a hash or other entity (and the history in a database).

In this final section, I'll breeze through the nodes and other data sources, giving you a quick introduction to each. This is our first look at this entire set of sub-projects, which will be keeping us amused as the months pass.

I have these loosely grouped in three broad categories:

- *Streams* are situations where I'll be sipping from the firehose of data from some other system that doesn't care whether or not I exist.
- *Nodes* are generally based on the Arduino microcontroller board, and are much more civilized because I'm writing the code. They respond politely to queries, and can also perform local control tasks.
- *Random Devices* add to the capabilities of Shacktopus, but don't fit into the previous two categories.

STREAMS

NMEA 2000

The navigation system aboard *Nomadness* is already in place, and depends heavily on this increasingly familiar marine networking standard that is layered atop CANbus. We have a Maretron [USB100](#) which purports to be a USB gateway from the N2K world, though it is only sold with Windows support. I am assuming that this is just a driver issue and is a soluble problem; if not, we'll have to roll our own or (preferably) leverage work done by others trying to break the industry stranglehold on the standard.

In any case, this will look like a continuous stream of PGNs (numbered data points) and

associated values. If we do end up with a more intelligent gateway, then it can be a bit better-behaved and respond to queries. But the default right now looks like an endless torrent of data reflecting activity around the boat that includes rudder angle, autopilot data, compass heading, GPS coordinates, roll/pitch data from the rate gyro, fuel tank levels as described in Issue #2, wind information, derived nav data when under chartplotter control, and other related points.

Outback

This is the ship's power management system, which includes an inverter/charger, solar charge controller, and the [company's](#) FlexNet DC monitoring device that reads shunt currents. The front end of this is called the MATE, and it has a simple ASCII serial protocol that dumps three data blocks once a second (one each for the inverter/charger, solar controller, and monitor). This is well-documented, and like the NMEA2000 feed, is a steady stream into a serial port. Hopefully we can parse this and throttle it back without having to add external hardware, though they have just released the new [MATE3](#) that might solve this problem while adding lots of additional capabilities. At the moment, according to company documentation, Ethernet and streaming are not yet implemented... so I'll develop around the familiar MATE that's currently in use.

```

DC TODAY minSOC 88%
In 4AH 0.05kWh
Out 52AH 0.63kWh
Bat -48AH -0.58kWh
  
```

Carnetix

The DC-DC converter that runs the Mac Mini is made by Carnetix, and it provides a small dataset via USB that includes its output voltages, currents, and temperature. This is

not highly critical, but we do want to keep an eye on it and do a bit of datalogging.

NODES

Next up, we look at the Arduino-based nodes scattered around the boat. These are all designed here, and respond only when queried... making interaction much more relaxed. Interface in all cases is either USB or serial (in the latter case, the nodes need to be locally powered, but can be further away from the hub without special USB range-extenders like the USB2ARC5M from B&B Electronics). XBee wireless is also available in any case where cabling is a major issue, as on the dinghy. All nodes have a smart status LED, though these can be suppressed under software control if they are annoying. These will be BlinkM units that can relay a lot more than a simple pattern without using CPU resources.

Sewage

This simple node (and the first one developed, already working on the bench) is located next to the forward holding tank, and performs a bit of trivial Boolean logic to sound a loud warning alarm if someone attempts to run the macerator pump without opening the thru-hull and the tank vent seacocks. These, like all other valves on the boat, have their positions sensed with either a reed switch or Hall-effect sensor and a magnet on the tailpiece. The node reports these as key-value pairs (HoldingVentValve=1), as well as the state of power to the pump, sink drain seacock, a nearby flooding sensor in the same compartment, Henderson manual pump cycles, and the rough level of contents in the holding tank (interfaced with a commercial device that uses proximity sensors). All this can be integrated over time for better

MORE NODES

prediction about flushes remaining and usage efficiency.



The photo above shows the development "busy box" for this node... a kluged set of tools that allow easy simulation of sensors and other connected devices. Behind the panel is an Arduino, and it plugs into the Mac via USB.

Companionway

This node is involved with security and access control, as well as I/O related to the pod over the sliding hatch. The area contains a few NMEA2000 devices (GPS, rate-gyro compass, and wireless base station for the autopilot), but also houses the APRS stand-alone [tracker](#) and a GPS [datalogger](#). This node switches their power and confirms operation by looking at the LEDs, and also owns a radiation monitor ([RadAlert](#)) with a pulse-count output.

Security functions include access-control devices (keypad and RFID reader), hatch and companionway door sensors, and a PIR sensor for observing motion. There is also an LED output for alarm status, blinking as in a car to convey the presence of a security system. This node may also be the most convenient way to switch power to a small camera in the pod, and will pick up a few things that are just handily close (like the door sensor to the aft cabin).

Pedestal

The outside helm (steering station) is a nexus of user-interface devices, the most critical of which are the chartplotter, binnacle compass, and Icom Marine VHF remote mic. None of these require any node support, though a security bit on the plotter might be a good idea. I see this lightweight application as a set of convenience features - a serial LCD that presents alarm conditions (without requiring browser involvement), keypad that matches the DTMF/voice system command set, source-selection input for video piped to the multifunction display. It's also a good place for a man-overboard proximity sensor.

Arch

Located behind the helmsman, up on the radar arch, this node owns the stern of the boat. Solar array security loop, solar temperature, control of the cockpit LED floodlight, stern camera power, downward-facing PIR motion sensor to observe the stern boarding ladder, LED sternlight operation monitor, and environmental sensors. This is also the best place to have an Xbee port for communication with the dinghy, to maximize range without needing anything more than the on-board antenna (a simple mesh network).

Dinghy

This node is in a very harsh environment, and also has more power and packaging challenges than the rest - it is located in one of the hatches of the dinghy. (While on the davits, it should have a charge input, though we can't depend on that since it can spend many days in the water.) It's largely for location tracking and security, with a sensor for the motor, a security loop, and an APRS tracker that is active when the dink is deployed.

Similar nodes may end up aboard the Hobie i12s and Pygmy kayaks...

Bow

At the other end of the boat, we have a fun one - embedded with a remote-controlled [Golight Stryker](#) searchlight with HID bulb, on which is mounted a sealed broadcast-quality video camera. This node takes care of position feedback, and parallels the stock motion control by hacking a second remote (the other is mounted at the outside steering station). It controls camera power, has a forward-looking ultrasonic distance sensor, and a circuit for confirming operation of the bicolor LED navlight assembly. Finally, as we add the bow thruster, this node will be available for current-sensing, deployment mode, and whatever else becomes relevant.

Galley

This one is mostly about temperature sensing, and is close enough to the Hub that we might be able to use a National Instrument [6008](#) I/O module (though that adds complexity by requiring different drivers). In any case, we want to see temperatures around the stove, woodstove stack temp (thermocouple), fridge and freezer thermal profiling, status of the refrigeration systems (power and heat exchanger pump), status of the propane solenoid, and anything else that reflects the condition of heating and cooling systems.

Engine

There's a lot of data down here, and it will take a node with I/O expansion to handle all the static input bits. One of the main applications is reflecting the fuel system on a distant graphic display; with 3 diesel tanks having both source and return valves, plus valves for the Racor filters and transfer pump, there are around a dozen magnetic sensors to check periodically. (Fuel tank levels are measured by TLA100 modules on the N2K network, though we can observe their resistance for a bit of

MORE NODES... AND RANDOM DEVICES

redundancy... but that's over in the inside helm region.) In the engine room, we will also want to see the position of the access hatches, raw water stopcock and tank-selection status. These are input bits that don't change often.

More dynamically, we need to observe some key engine temperatures (block, a few spots on the heat exchanger, and two spots on the exhaust system), pick a tach pulsetrain off the propshaft, note the bilgewater depth and pump status, and probably a few other things I haven't thought of yet. We might be able to derive some additional engine data from a Maretron product that accepts the wiring harness (no intrinsic J1939), but that would not affect this node. There is also at least one output bit - a "jog" for the Webasto heater diesel pump, necessary to bleed the system when it has sucked air. An engine room camera that can see filters is a good idea as well.

Helm

The inside steering station is a complex region, though the nav heavy lifting is handled by the N2K network or existing instruments (autopilot, charting software on the pivoting Mac screen, Furuno radar, engine controls, N2K display, hydraulic steering control). A node here is auxiliary, presenting the same status LCD that is at the outside helm, observing tank sensor resistances, reporting access panel states, and so on. There is also another little keypad that echoes the command set of the DTMF/voice system.

Power Distribution

This is a busy one, and should not be confused with the feed that comes from the Outback system. The job of this node is to reflect the entire status of the ship's power distribution system - all DC breakers, state of AC source selector switch, AC present, and anything else that can be

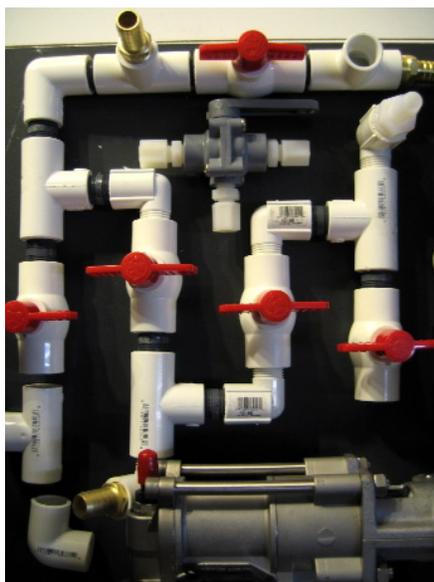
glommed via optocouplers. There is also some active intervention via SSR modules... whatever we decide needs to be optionally software controlled (in parallel with manual breakers) will need an output bit. A local LCD is probably wise here, and maybe this one should be the MAKE controller instead of the more anemic Arduino.

Midship

This is just a bunch of simple sensor bits, and is located behind the video screen in the lab region (fairly central). It reports the status of doors, drawers, and cabinets; bilge flood sensor, perimeter sensors from the deck, ambient temperature, local PIR motion detector, kayak security loops, deck box lid and internal temperature, monitoring the activity of the nearby Isotherm water heater, controlling the gear pump for the solar water heating loop, and so on. Lots of trivial stuff, which together gives a good picture of human activity aboard.

Waterworks

This node should be a fun one; it is embedded in the fresh-water processing region on the wall of the



aft head compartment. It knows the positions of all water-routing valves, and has a [flow sensor](#) at a choke point. A small display and keypad is used to report a maintenance activity like changing a filter, and this allows software to maintain accurate usage data to drive the PM schedule. At the moment, the only water tank level sensors are pneumatic (Tank Tender), and if we're good, we can use flow integration, pump and valve data, and other cues to maintain accurate level info (like coulomb-counting in a battery monitor). This node also owns the TDS meter and the reverse-osmosis desalinator.

RANDOM DEVICES

Let's look quickly at the other interfaces to this sprawling system (see why the name *Shacktopus* fits?)

Crossbar Network

This is a sparse-matrix, signal-agnostic network of latching relays controlled by SPI shift registers... about which MUCH more later. It connects anything to anything.

Communication Gear

The Icom M802 marine HF rig and the Kenwood D710A both provide considerable information on their serial ports (and are fully controllable). This system will need to accommodate those, as well as interface with the PACTOR interface and other standalone systems in the console.

Router

It will be worthwhile for the system to periodically access the Cradlepoint router and get a log update.

KEEPING TRACK OF IT ALL

Derived Data Points

Throughout the system there are "soft" data points that are the result of some computed state, human-entered values or commands, time-specific events, and so on. These should be databased just like anything else.

Alternate Data Types

Finally, we should keep in mind that there are things like audio and video channels, textual annotations, and images. These are very relevant, and need to be considered in any overall catalog of ship data points. Some may even be databased, like time-stamped log entries or maintenance notes.

As you might imagine, this sprawling system involves quite a bit of planning and data management... it's a challenge to maintain the consistency of namespace across multiple drawings, SQL tables, web objects, and software environments ranging from Arduino C to DataPrism and Perl. I've set up a FileMaker database to keep track of data points, and you can see one of the records here.

Thanks for subscribing!

On with Development!

This issue has been uncharacteristically monolithic with one long and chewy article about the system, but it should be a handy reference as we move forward on more granular projects. We have now set the context for the entire ship network; at the moment, there is nothing in the domain of *Nomadness* geekery that hasn't been at least prefaced here.

The immediate plan this week is to set up the development system and do the "hello, world" of data collection... in parallel with a few urgent mechanical projects. I ran out of room in this issue for the letters column, but I have one in the queue and welcome inquiries about the topics covered so far.

Cheers from Nomadness!

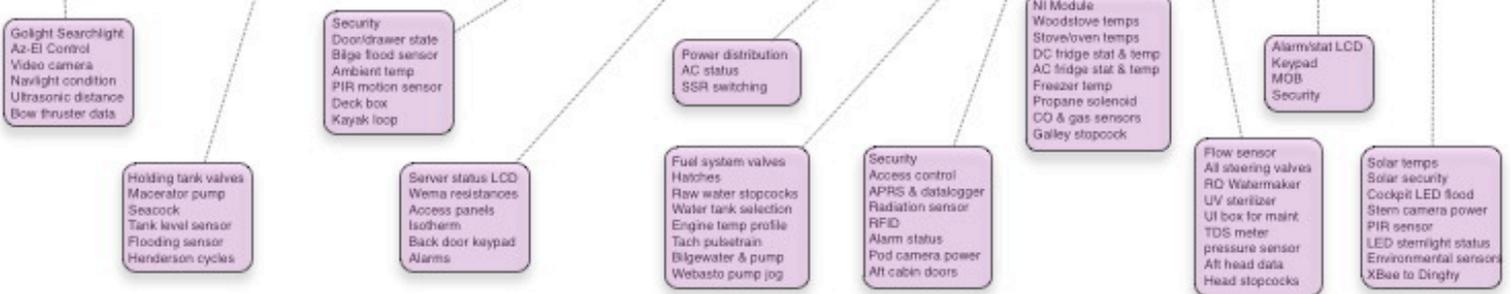
-Steve

Nomadness Data Point Library

Name ForwardSinkDrainValve	Category Sensor - Bit
<small>Basic Description, value range, units</small> Status of stopcock on forward head compartment sink, under settee. Value is True if valve is open (inverse of Arduino pin).	<small>Search Tags</small> <input type="checkbox"/> Audio <input checked="" type="checkbox"/> Valve <input type="checkbox"/> Video <input type="checkbox"/> Temps <input type="checkbox"/> Serial <input type="checkbox"/> Engine <input type="checkbox"/> Power <input type="checkbox"/> Flooding <input type="checkbox"/> Security <input type="checkbox"/> Alarms <input checked="" type="checkbox"/> Plumbing
<small>Details</small>	<small>Node</small> S - Sewage
<small>Record ID</small> 5	
<pre>sinkDrainValve = IdigitalRead(sinkValvePin); Sensor is reed switch on pin 4</pre>	

New





A NOMADNESS SAMPLER

As a break from last week's chautauqua on the ship network design, this issue presents diverse fare that is reflective of the way things normally go with a huge project: frequent distraction from central focus by maintenance issues, random side tasks, bits of blue-sky philosophizing, Red Alerts, input from friends, and so on. A massive engineering job rarely has the kind of clear, steady focus that we would like to imagine.

In fact, the tagline above is a reference to a piece I wrote a while back that captures this pretty well. If you follow this link to [Gonzo Engineering](#) and then read the section "Formal Tools, Briefly Considered," it will be a pretty good snapshot of how things proceed in practice... despite the seductive clarity of a big system drawing.

In this issue, we look briefly at the underwater profile, meet a fellow technomad (the first "Subscriber of the Week" feature), breeze through a few short subjects including the Oil Change from Hell, then look at the emerging documentation standard aboard *Nomadness*.

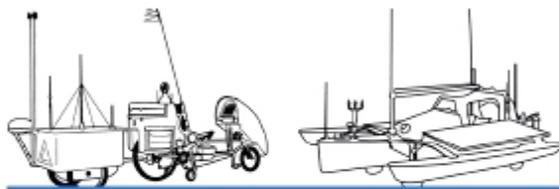
-- Steve



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(image above is from the 2010 haulout, lying on hot tarped concrete with grinder in hand.)



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REDNECK BOW THRUSTER

Underwater Profile

Last summer, as I wrestled with logistical alternatives, *Nomadness* spent a few months in Olympia. While there, she spent a few weeks on the hard in Swantown Boatyard, where I worked with Shurtz Marine on a full bottom job.

Fortunately, they let me do most of the work myself, offering all the advice I needed and happily selling me supplies, but only starting the clock when I had their guys take over. I did all the hull prep, including acid-etch and endless priming of about 200 bare steel spots in addition to a very messy keel-bottom (clearly skipped in the last haulout or two). I was delighted that none of this involved any corrosion... the hull is in beautiful shape. By the time my work was done and they did the bottom job with pricey Interlux [Micron 66](#), I was getting very familiar with a side of the ship I rarely see ([more here](#))

One thing I did discover, though, is a big reason for the difficulty in maneuvering at low speed or in reverse. If you look closely at the photo below, you can see the 3-blade MaxProp at the trailing edge of the keel. Then there is an 11-foot gap, followed by a stout skeg-hung rudder. This means that there is none of the phenomenon known as *prop walk*, common to almost all boats and highly useful (once understood) for close-in handling... kicking the stern predictably to one side. Also, a prop close to a rudder throws prop wash over its surface, allowing quick turning response at low speed.

Nomadness, on the other hand, tracks very straight and only steers when there is *steerageway*... enough speed to start seeing hydrodynamic action on the rudder. But getting her to respond predictably from a standing



Expedition Medical Chests

My primary business model is a decades-long refinement of what Don Lancaster (in ISMM) once called "nickel generators" - small, low-stress products that fall naturally from pursuing our passions. These Expedition Medical Chests



are gasketed Lexan boxes for the harsh marine environment (unlike others on the market), and contain ER-grade supplies (thanks to my partner, who is a nurse). Initial response has been very good, and they were featured in [Three Sheets Northwest](#) this week, then picked up by [Navagear](#), [Bitter End](#), and others. Yikes.

See the [Medical Chests](#) website for more info... including a new marine medical blog by my partner, Kirsten. If you have gruesome tales of injuries at sea you'd like to share, please let us know!

start is tricky, and in reverse her helm-answering can best be described as random.

Before I start involving insurance companies in docking maneuvers, I need to deal with this. Old-timers may snort with derision, but if ever a boat was a candidate for a bow thruster, it's this one. Essentially, this is a laterally oriented reversible prop as far forward as possible, allowing the helmsman to kick her over one way or the other.

That sounds great, but the quote from Cap Sante Marine for installing an 8-HP Lewmar was \$13,000!

One of the key projects on the list for my welding guru, therefore, is what I call the *Redneck Bow Thruster*, a deployable rig that does not involve drilling a 180mm hole through my boat. This approach puts the thrust further from the center of lateral resistance, with a longer moment arm that should render it more effective (though fiddly).

I hope to have news on this project in the next few months... it's an essential one.

TECHNOMADS

Ages ago, in 1983, I took off around the US on a [computerized recumbent bicycle](#). This was well-timed, blending the new technologies of portable computing and networks with the ancient ones of nomadic lifestyles and writing for a living. The media loved it, sponsors jumped aboard, and the loosely defined concept of *technomads* was born.

Many other people have chosen to explore concepts of technology-enabled wandering, and there's a whole lexicon of terms for variants on the theme: Location-Independent Professionals, NuNomads, and many more. I even have good friends who call themselves [Technomadia](#)... and they are making the transition to a bus like Ben here.

I had a bus epoch long ago, though it was not very geeky... my partner, Maggie, and I covered 16,000 miles around the US after my *Computing Across America* book came out in 1988 (republishing that is on my hot list). The tales of that time are in the *Miles with Maggie* sequel, available in my antique [PDF store](#).

The photo below was from one of our more dramatic bus adventures, though if you want *real* Photoshop wizardry, meet Ben....



Subscriber of the Week: Ben Willmore

The technomadic community has been steadily growing over the 27 years since I playfully coined the term; adventurers in all modes on land, sea, and air are developing net-centric lifestyle models and mobile gizmology. Ben teaches [Photoshop seminars](#) around the US, and currently lives in a beautiful Prevost bus with his partner, [Karen Nace](#).

He is now working on a [vintage bus](#) project, extensively networked with distributed control and power management tools... with two robust computer workstations (20 Terabytes of storage!) and a kilowatt of solar panels. The monitoring system under development is very similar to mine, in that it is both locally and remotely accessible via browser.

Ben and Karen travel full-time, doing fine-art photography and spending time with fellow technomads. His [primary blog](#) is updated weekly with their adventures... always a good read!

Interested in being featured here? Let me know! Subscribers to this geekily esoteric publication tend to be pretty interesting folks...



SHORT SUBJECTS



Another Take on the Step Seat...

Remember the little upholstered seat that was shown in Issue #1? My old friend [Sven Grenander](#) saw right through it, literally, and commented that it would be a great way to conjure a workbench when needed... even holding a clamp-on vise. Here's a photo from before the fluffy stuff; if I had thought of that, I might have made the cushion a detachable (velcro-on) module instead of the traditional stapling.

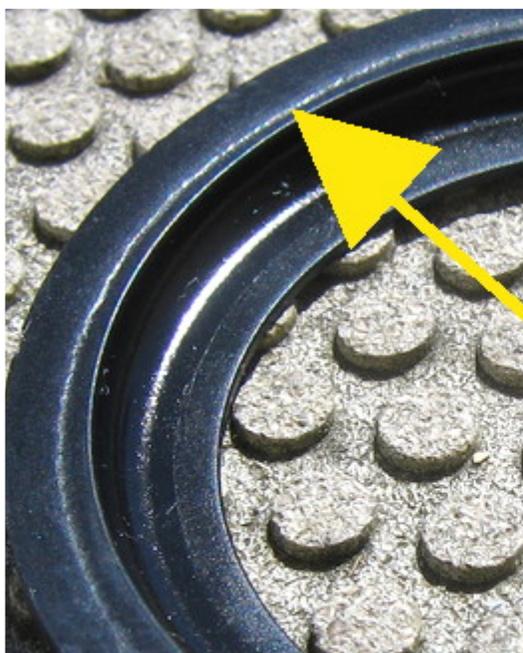
The Ship's Piano

One of my regrets in life was not learning music at an early age; I've always played the flute, but never with any actual knowledge of theory or ability to read music. Four years ago, I decided to just jump in, and started playing the piano... getting on a Satie kick a couple of years ago. This little pic is from my [YouTube performance](#) of the Gnessiennes #3 and #4. Why is this relevant here? The piano is going to be integrated into the lab desk, hidden by an access panel that becomes a full-width music stand when open. It's not all about the geekery!



Belated Photo Credit

The delightful image of Captain Kirk at the piloting console of Nomadness in Issue #3 was done by Phillip Mark Rodriguez in Knoxville, using a random frame grab from my boat webcam.

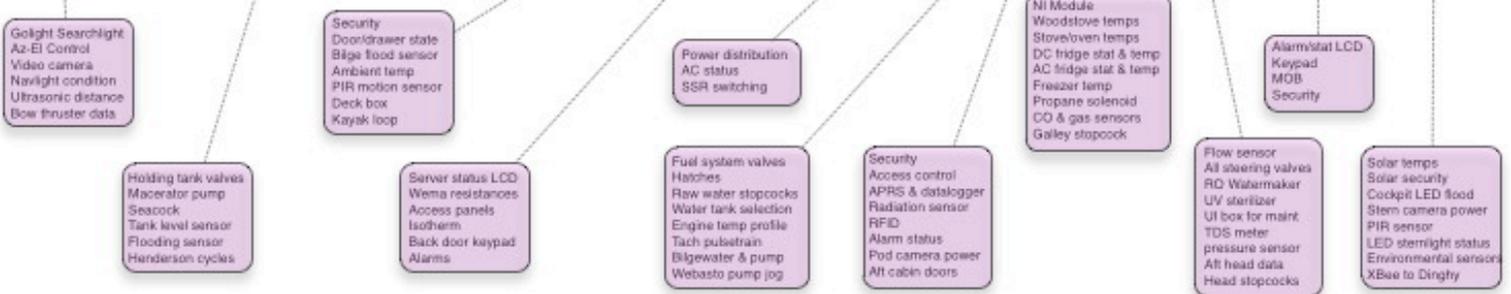


The Oil Change from Hell

Here's a warning for anyone who has recently purchased a boat... **assume nothing!** I certainly should have known better, but when I did my first Yanmar oil change a few months ago, I just looked at the existing Fram filter (PH2856), crossed it to a locally available NAPA 1381 (Wix), and did the job. Within seconds, all the engine oil exploded into the bilge with a horrible noise, and I'm indebted to George Pell, my dock neighbor who was helping, for thinking quickly about shutdown and bilge-pump disabling before things could get *really* messy.

Looking closely, we discovered that the new gasket was only barely contacting the flange on the engine, and that the old one (which I had been using for about 140 engine hours including dangerous moments on [lee shores](#)), was the wrong filter type! It had never even occurred to me to question something that came with the boat, but you can see in the photo that the indentation is not only unevenly distributed around the ring but also a mere 50 thousandths of an inch wide at its narrowest. That bit of rubber is what was holding my oil in since I bought the boat.

The correct filter for the Yanmar 4JH-DTE is the Yanmar 129150-35152, which is now in stock. Removing 7 quarts of oil from the bilge is not an experience that I wish to repeat (but at least it shot down instead of up into the pilothouse!).



SPECIAL ISSUE ON THE MOBILE LAB

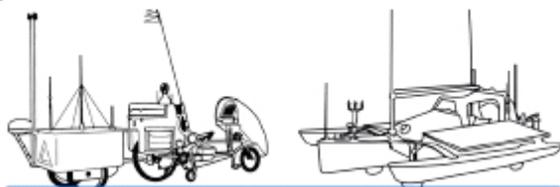
Issue #1 introduced the *Nomadness* development facilities in La Conner, a trio of rental spaces consisting of moorage, a "retail" staging area for system integration, and the *Polaris* mobile lab for deep geekery.

I built the latter over a year ago, when it was clear that I was in an impossible situation regarding R&D space for boat projects. Since I was in no position to buy a house and shop adjacent to moorage (though I spent months looking), the obvious hack was to distill my sloppy 3,000 square-foot Microship lab into a portable toolset that could be deployed wherever *Nomadness* happened to be parked.

As it turned out, even that was a non-trivial problem, since marinas rarely offer secure, powered trailer parking. But eventually I found a situation that works, and this rig is now secure in a building about 2 blocks from the boat.

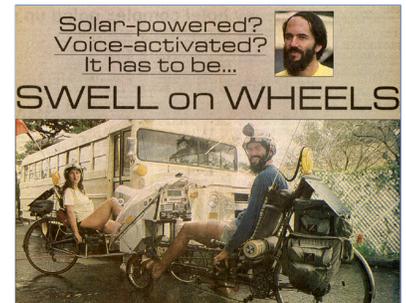
I first wrote about *Polaris* in [Make:Online](#), the excellent blog associated with [MAKE](#) Magazine. This issue of the *Nomadness Report* expands upon that 4-part series, and may help others with boat-shop logistical issues.

-- Steve



Nomadic Research Labs

Applied technomadics since 1983
microship.com



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The photo above shows my first geek mothership... a converted school bus in 1988. This issue features a much newer version.

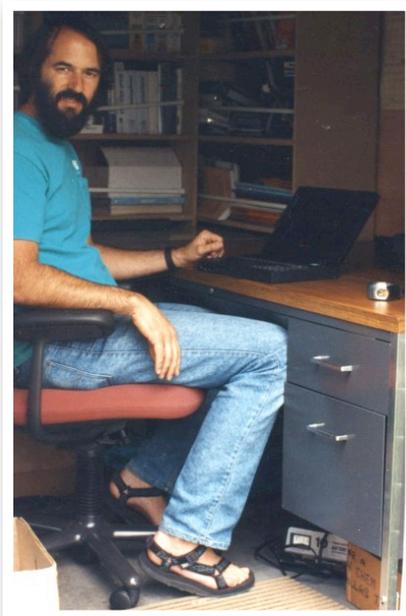
POLARIS BACKGROUND

Make it Anywhere...

There are lots of reasons why a fully portable lab might be worth considering: a lack of workspace in your house, maintaining continuity through a move, hauling your toolset to a client site, conjuring a nomadic hackerspace community that can coalesce around projects, “bugging out” without losing effectiveness, creating a private shop without construction legalities... or just because it’s efficient, cool, and away from distractions.

In my case, I had an absurd logistical dilemma. I’m trying to complete an intensively geeky sailboat project, but my house and shop are on an island with no moorage. A four-hour round trip between home and boat proved to be an insurmountable challenge: I would arrive at the marina, all set for a few days of hacking away at the to-do list, then immediately run into a missing part or fabrication job that required tools back home. OK, back-burner that job, move on to the next, encounter a similar problem. Repeat until exhausted. Hang around visiting other sailors for a day, then drive back to the lab with an even longer to-do list and a sense of frustration.

After over a year of getting too little done, I realized that the solution should have been obvious up front: build a mobile lab, rent out the real estate, and move all operations to *wheel estate*.



My first Wells-Cargo trailer lab, circa 1991. This covered over 100K miles on the BEHEMOTH speaking tour.



A Necessary Monster

(to borrow an apropos title from [George Dyson](#), who used it to describe his over-the-top 48’ Mount Fairweather baidarka)

This was my second Wells-Cargo trailer, and it is as long as Nomadness... 44 feet. There was a king-size bed in the gooseneck over the pickup truck bed, and the interior held both Microships as well as the BEHEMOTH bicycle.

But this was too much... one 15,000-mile haul in the summer of 2000 was enough, and it sat in the forest outside my lab for a few years before being sold.

Although I must admit, now that I’m using my third mobile lab as primary workspace, I have frequent moments of wistful longing for all that square footage!

Thus began the *Polaris* project, a tight and efficient electronics lab and workshop built into a 24-foot utility trailer — a distillation of my sprawling 3000-square-foot building (originally the Microship lab). Ancient dusty inventory parked on shelves was abandoned *en masse*, and countless tooling redundancies were eliminated as I applied years of experience to building a workspace focused on current activities instead of the “might need it someday” mentality that had spawned a shop overflowing with dormant tonnage.

Almost immediately I found that I prefer working in the mobile lab, and it has quickly become much more than just a miniature of the old one. It contains a ham radio station with deployable antennas, robust security and networking tools, marine-grade stereo with embedded iPod and Sirius satellite, excellent lighting, and all the parts for upcoming boat projects. Resources include a cabinet of hand and small power tools, drill press, folding table saw, sander/grinder, compressor with a few air tools, bench vise, gas welder, industrial sewing machine, toner-transfer PC board fabrication gear, and (very soon) a [Makerbot](#) Thing-O-Matic. The main lab bench offers a 4-channel Tektronix scope, Metcal soldering station, stereo microscope, power supplies, a stock of Arduino goodies, and the usual suite of small test instruments. And the inventory, at last count, fills 869 drawers — including a wall of small-parts cabinets that are secured by a folding 8-foot whiteboard when underway.

Naturally, everything must be able to accommodate the dynamics of being on the road, so all the furniture (mostly well-built old steel stuff) is bolted down. Every drawer or cabinet has a locking method, and a pre-flight checklist by the door helps make sure I don’t do something stupid that would result in a parts gumbo on the floor after a few bumpy miles.

Let’s take a look at the details.

POLARIS SUBSTRATE

The Platform

Should you find yourself needing to conjure portable workspace, the first issue is the substrate itself. The harshness of life on the road requires attention to issues that don't arise in traditional structures except perhaps briefly, during earthquakes; vibration and lateral acceleration can destroy cheap furniture and scramble your inventory.

The first decision involves sorting through trade-offs in robustness, hackability, and cost to choose the substrate itself: van, RV, trailer, container, bus, truck, or other vehicle. I'm not impressed by the construction quality of most RVs, for example, but they're common enough to have a pretty good cost/performance ratio, and in a declining economy, can often be found at a tempting price. The trouble with them is that most interior space is devoted to human comfort, and you'll thus end up with either a small lab tucked into remaining corners, or a major operation to gut your rig; neither very appealing.

Buses, however, can be spectacular substrates... the MCI or Prevost machines made for Greyhound have a design life of 2-3 *million* miles... compared to the 100K or so of a typical RV. If I were living and traveling full-time in my mobile lab instead of just parking it, this would be my first choice.

Shipping containers are rugged and secure (from intrusion as well as the elements). They are available cheaply in US port cities, piling up due to global trade imbalance, and 40-footers can be had for as little as \$1-2K if you shop around. They're not very mobile, however, unless you own a large truck; moving them is a turnkey process, but you'll pay. The good part of this is that you can ship one pretty much anywhere in the world and assume that it will arrive in one piece. Containers are also dimensionally standardized, and can be combined in a variety of ways to build a whole compound at a fraction of traditional construction costs. If you need to conjure a cheap shop building and don't plan to move it very often, this is an excellent option.

Still, I prefer more convenient mobility (and more space than a van), so for my application, I chose a utility trailer. These are made by about a dozen vendors with various levels of quality and a wide range of costs. My choice was the 24-foot [EW-2424](#) from [Wells-Cargo](#) (this is my third from them) but it's by no means the only game in town. New price on these is absurdly in the \$10K range, but sometimes they appear on eBay or Craigslist at bargain prices.



Empty trailer, ready to begin



The Polaris substrate is a 24x8 foot box on wheels, with a "Nose Cone" for reduced wind resistance, fold-down ramp door at the stern, man door near the bow. GVWR is 10,000 pounds, or a little over 3 tons in real capacity.

INSULATION AND CARPENTRY

Trailers of this class are basically big mobile boxes with plywood floors and skinned walls, with metal ribs and a lightweight roof structure. They range from 8-48 feet long and 6-8 feet wide. They're easy to hack, and can be purchased with lots of useful options, including insulation, windows, E-track, and tie-downs for lashing, power, lighting, folding steps, ramp doors, roof vents, air conditioners, and more. Mine was off-the-shelf and fairly basic, so the first job was to take it apart and insulate walls and ceiling... not a fun job.



The structure is simple: exterior steel skin supported by "hat section" ribs that also carry the internal plywood sheathing. The space between is so thin that I had to peel away about half of the R-13 insulation batt thickness; the net effect is much better than the original uninsulated space, but I wouldn't call it cozy.

The roof involved a different method — rigid R-Tech skinned foam, an added headliner, and wooden cross-members to clamp it all in place. Your mileage may vary considerably, depending on trailer



construction. If you have the opportunity to order a unit to your specs, I highly recommend letting them do this nasty job. In my case, the insulation project dragged on for a few weeks.

The boundary between wall and ceiling created an interesting challenge — a combination of the non-square roof crown, curvy aluminum cap rail, and my own contributed imperfections. I ended up making a dozen fitted doors with cabinet hinges, stuffing insulation behind them, and using the newly



created full-length channels (with gaps every four feet) for cabling.

With the shell of the trailer now insulated and buttoned up, there was still a major issue to address before bolting down furniture. I was clearly going to need a place to install the systems — power management, security, radio communications, and networking tools. The obvious spot was at the bow, where I added a door inside what Wells-Cargo calls



the "nose cone," which is visible on the previous page.

The latch is a Southco multipoint unit that engages receivers at top and bottom, making it easy to open and close the door with a single twist-lock. I insulated the fiberglass nose with a couple of batts, and mounted the 30-amp marine shore power connector near the bottom (just above the trailer tongue shelf where the generator sits). This space is now packed with wiring & control panels.

Finally, there was one remaining "substrate" issue that needed attention: with side and rear doors closed, the lab-to-be was pitch black inside. Since the trailer had not come with optional windows (and my planned interior layout gobbled all the wall space anyway), the only airflow was through a couple of tiny flow-through vents designed to prevent mildew. Besides, when sequestered inside the rig, I want a way to peek out and see who's pounding on the door before releasing the lock!

In the nautical spirit, I prowled



eBay and picked up a discontinued Beckson opening port. Given my 6' 4" height, I wanted this close to eye level... and that ended up removing a structural beam in the door that connects the upper hinge to the frame. Always something.

The solution is at least as strong as the original, and gives the rig a somewhat salty air: I carried the door structure around the port hole with a frame of marine plywood, and called it done.

FURNITURE & FIXTURES

All that boring stuff gets us to the point where the rig is ready to accept fixtures for work surfaces and inventory stowage.

Harsh environments like this are a challenge, although I've found it almost relaxing compared to building systems for the marine environment (*water corrodes; salt water corrodes absolutely*). The problem here is movement: lateral acceleration, high-frequency vibration, cyclic loading over time, and abrupt shock. Cheap office furniture will shake to pieces, inventory drawers need to be held shut, and high-mass items on moment arms will eventually fail.

Every mobile lab project will be shaped by the needs of its owner, so rather than any kind of recipe, I'll offer a little smörgåsbord of methods that worked for me.

The first challenge is finding suitable furniture. Forget laminate kits from big box and office-supply stores; what you want is good stuff from the days when things were built to last. Pieces from grand old brands of the last century (Steelcase, Steelmaster, Cole Steel, and others) can be picked up at surplus places, auctions, and if you're lucky, just for the effort of hauling them away from someone's office renovation project. In *Polaris*, steel units include an 8-foot steel work table, 5-foot standing workbench, file cabinets and drawer units, a gorgeous old desk... all of which work smoothly. The only large item that diverges from the theme is a hulking 10-foot wooden multilevel table that I got for free about 20 years ago, almost dumped because it was too hard to move.

The newfangled way to arrange all this, of course, is to model your space in Google SketchUp... but I



just cut Post-It notes to scale and played with them and "Mr. Template" on a piece of graph paper until it made sense. However it shapes up, things start to get interesting when you drag the first piece of furniture into your mobile platform and have to figure out how to keep it in one place.

My trailer has a plywood floor with steel joists underneath; it's easy to crawl under there with a socket wrench. Many things (like the old workbench) are simple jobs, as long as they have legs or surfaces that can be mounted either directly or with angle brackets.

I similarly bolted down the air compressor (removing wheels and handle, then adding a block to level

it), floor-mount drill press (3/8" stainless bolts with acorn nuts on top), most of the steel furniture, the massive wood table, and a few minor items.

But attaching things to the walls gets a little trickier, with only thin plywood sheathing and steel ribs that you can hit with self-drilling sheet metal screws. I don't trust this with significant loads, and suspect there may be some flexion in rough conditions.

If you have a chance to specify E-Track when buying a trailer, by all means you should do so — it's a standard with lots of readily available fixtures. An "industrial" rig like a container or big truck doesn't need this, since you can tack-weld brackets where needed... but on a lightweight machine like mine, the additional wall structure simplified mounting throughout.

There are four instances of E-Track in the bottom photo. The little ring hanging by itself at the left is used by a short webbing strap when underway, angled down across the drawer faces of the low cabinet to an eye bolt in the floor. The Honda generator (which moves outside to a shelf on the tongue when needed) is snugged against a foam pad on the wall by a strap that wraps around the unit and through the handle. The tall tool cabinet is kept under control by a ratchet strap, and yet another provides a backup to floor bolting by wrapping around the 8-foot long bench barely visible to the right.

Easy solutions are the best, and redundancy is cheap insurance. I also use simple strapping to keep the folding Bosch table saw from wandering around, and while underway the drill press is stabilized to the wall to keep it from wrenching itself loose.



THE PARTS STORAGE CHALLENGE

Keeping furniture and other big stuff under control was mostly straightforward. But preventing little stuff from flying around is much trickier.

Where possible, I took advantage of existing locking schemes (steel desk, file cabinet, and the tall tool box). The wood desk has a drawer that's easy to lock with a pair of screw eyes and a pin. But there are three major "inventory regions" that involved special challenges.

Large parts and some tooling clusters live in an array of 32 Rubbermaid bins that slide into homebrew shelving atop the 8-foot steel bench. To keep these in place on a hard right turn, there are eight wooden bars that lock in place with a



protruding screw in the bottom (engaging a hole) and a hook and eye at the top. Simple, but solid.

Smaller but still bulky parts reside in a pair of steel cabinets with a total of 63 drawers mounted to my desk (and held to the wall by an E-Track strap at the bottom and bookshelf brackets at the top). This one was kind of annoying, and my preferred method involved serpentine line, pulleys, and cam cleats. But somewhere between gathering parts and drilling holes, I discovered that it would have to come off the desk for surgery... and being fundamentally lazy, I dropped back to the simple-but-ugly solution shown here.

The spring clamps at the top are at their limit, and keep the strapped-on boards from wandering off at



funny angles while helping with the task of keeping them in place. In the photo, you can also see the bookshelf... this continues another couple of feet forward to a bracket on the forward wall, and is mounted to the side wall by two very heavy brackets encapsulated inside foam-core veneer-skinned sandwiches (to be nice to adjacent books). A shock cord runs the full length, keeping the library from taking a dive on an abrupt tack to port.

But the most ambitious drawer-retention challenge was the Wall of Inventory — 755 small-parts drawers. Their cabinets are all screwed to the wall and tightly constrained between a top shelf and the base, but a hundred thousand or so bits of hardware would be a nightmare if they got out of control.

To solve this problem (and provide a useful brainstorming surface), I made a hinged 93×32-inch framed whiteboard with a couple of additional 9-inch wings that cover the cabinets above the speakers. This

latches down with marine-grade slide bolts (which glide across the mounting shelf and drop securely into receivers with a satisfying clunk). When I need access to inventory, the whiteboard swings up and latches to the ceiling... and a little nacelle of leftover space handily holds the Metcal soldering station base unit. You can see it below in both modes.

The whiteboard itself is Melamine "tileboard" or "shower board," which is around \$10 for a 4×8 sheet at the big-box home improvement stores. It's 1/8" thick and very easy to cut, though the edges bump easily and framing is recommended. This stuff behaves well with standard dry-erase markers, but will stain if you leave drawings for a long time. A proper whiteboard material of Ceramicsteel would be tempting for its magnetic properties and greater longevity, but weight and cost are issues.

The hinge structure was critical; in order to provide a stable mounting edge, I had to bring a top shelf out from the wall. This ensures that the four hinge pins are collinear, and carries the static load of the whiteboard as well as any dynamic loads encountered on the road. It also provides additional support by encapsulating the stack of cabinets... they're not going anywhere!

This is by no means complete — I still have to tie off or otherwise protect loose items like lab instruments that I'm not ready to bolt down. All these steps are collected in a preflight checklist pinned to a bulletin board by the door, since it is very easy to make a costly mistake.



MOBILE LAB POWER

My installation was shaped by equipment I had on hand (and a general preference for marine hardware), but is by no means cast in stone. In fact, a minimum configuration may be all that's needed if you're creating an alternative to a traditional outbuilding: run a cable to a dedicated outlet on your house and distribute power internally with a generic breaker box. At this level, "big box store" resources are adequate, and there's no reason to get fancy unless you need to survive power failures.

But a mobile workspace calls for batteries, an inverter/charger, and at least one primary energy source.

The control panels are mounted on a door that I cut into the nose of the trailer, which was easy since it has an aerodynamic "nose cone" that renders that area conveniently hollow for wiring. In most installations, a power panel like this would require either an additional enclosure or repurposing existing cabinetry (as in an RV). From upper-left to lower-right, the access door carries:

- DC circuit breaker panel (lights, embedded systems, and auxiliary jack)
- Control panel for ProSine 2.0 inverter/charger
- Analog AC voltmeter directly connected to main bus
- Link 10 battery monitor (fuel gauge)
- AC circuit breaker panel (main switch, lighting, desk, forward benches, machine tools)
- Control panel for Trace C40 solar charge manager
- Indicating fuse socket for loads connected directly to shore power

To the left is a water bottle in a cage, which is actually a pack of Lithium-Ion batteries. The charger for this is local, providing a handful of isolated DC when needed.

Below the door is a GFCI outlet and light switch, both protected by a stand-alone fuse. This may seem redundant, given that gorgeous marine-grade AC breaker panel with two unused positions, but I felt it worthwhile to provide a power source that is connected directly to shore power upstream of the whole inverter/charger environment (in case of system failure... I don't much trust that ProSine, which used to misbehave occasionally in my boat).



To the right of the AC outlet is a 12-volt DC "cigarette lighter" socket. That is an ugly and anachronistic connector standard, but it's handy for appliances like hand-held spotlights and other automotive-grade stuff.

Continuing down, we see the two big boxes: a 2-kilowatt inverter/charger and the solar charge controller. Neither of these would be my first choice in a new installation, but they were lying around the lab; the ProSine is inefficient and noisy, and the Trace is nice but has long since been superseded by more efficient MPPT (maximum power point tracking) solar charge controllers from a number of vendors. If you venture into this territory, I recommend [Home Power Magazine](#) as an excellent information resource.

The heavy red and black battery wiring is next: a main disconnect switch, 300-amp fuse block, a shunt for current measurement... then the cables (2/0 size) disappear into a steel cabinet where they are connected to a bank of AGM deep-cycle marine batteries.

Behind the access door, it's the usual rat's nest of power wiring. The key bits of advice here are to provide a generous hinge loop to minimize focused wire flexion, use stranded wire only, and make sure cables are well clamped before they are terminated (to prevent breakage at the stress-riser of a crimp).

This may look like a crazy amount of power-related hardware, but consider the capabilities, starting with the 30-amp marine shore power connector mounted on the outside of the nose cone (a very short cable run to the main breaker). Normally, I have a standard marine cordset

MOBILE LAB POWER, CONT'D

running to a nearby building (house, lab, or marina), with a pigtail adapter on the other end that converts it to the 3-blade RV standard. This keeps the hardware interoperable with boat stuff.

I have a couple of other AC options. First, if needs are modest (lighting and office equipment, not machine tools), I use an adapter that converts to a 15-amp household-style plug and go sniffing for an outlet with a regular orange outdoor extension cord in hand. Failing that, the pigtail adapter is long enough to plug into a quiet little Honda eu2000i generator (2 kilowatts) that rests neatly on a shelf just below the nose cone.

Regardless of the AC source, the internal path is the same: a 30-amp main circuit breaker directly feeds the inverter/charger, and its output returns to the panel and feeds all the branch breakers. When AC is present, this keeps the battery bank charged, but if shore/generator power disappears, then it immediately switches over to inverter mode and continues to provide AC. In other words, the whole thing is just a giant UPS (uninterruptible power supply), and the change-over is so quick that I barely detect a flicker.

Meanwhile, DC loads are derived directly from the battery bank. I'm based in the Pacific Northwest, so sun can be a little iffy at times... but the system is set up to handle a large solar array on the roof (on hand, but not yet installed).

All current in and out of the battery bank passes through a shunt on the ground side, which generates a proportional voltage drop (50 millivolts per 500 amps). This, along with terminal voltage, is monitored by the Link 10 (harvested from my boat when I pulled out the



legacy stuff and installed new Outback power management gear). Displaying real-time volts and amps, along with an amp-hour tally, fuel gauge, and extrapolated time-to-empty, it goes nicely with my retro AC voltmeter.

As you've probably noted from some of my comments, there are many ways to put together a system like this. If I were

starting fresh with a healthy budget, I would use all [Outback](#) equipment. From what I've observed on the boat, their gear is remarkably quiet (in both RF and acoustic domains, unlike the ProSine) and able to withstand random insults like shore-power glitches

without pathological side effects. All their hardware talks Ethernet, so a suitable system for a mobile lab of this scale would consist of an inverter/charger, solar charge controller, battery monitor, and network hub... plus a "MATE" display to serve as the single user interface to all of it. Conveniently, this device has a serial port, allowing easy data logging and remote access.



Closing Notes

All this just gets us to the point where we have a useful toolset for boat projects, but I'm going to leave it there for now... stopping with mobile lab infrastructure. In future issues, this will be a recurring fixture, as it provides a stable workspace for fabrication jobs as well as a parking spot for the sprawling inventory needed to take on a project of this complexity.

I urge you to consider this approach if you find yourself stuck for lack of workspace, impossible commutes to the boat, or restrictive marinas that panic at the sound of an electric drill. Whether "high-profile geeky" or stealthily tucked into a funky old panel truck, a mobile lab can keep you working.

ON WITH THE PROJECTS!



Special offer... 5 free issues

Do you have friends who would enjoy partaking of this weekly nautical geekery? For every new subscriber who mentions a referral from you, I'll extend your subscription by 5 issues. As I continue migrate my primary publishing context from the blog to the Nomadness Report, I need to get the word out... this is a great way to grow the network.

Cheers, and thanks for subscribing!

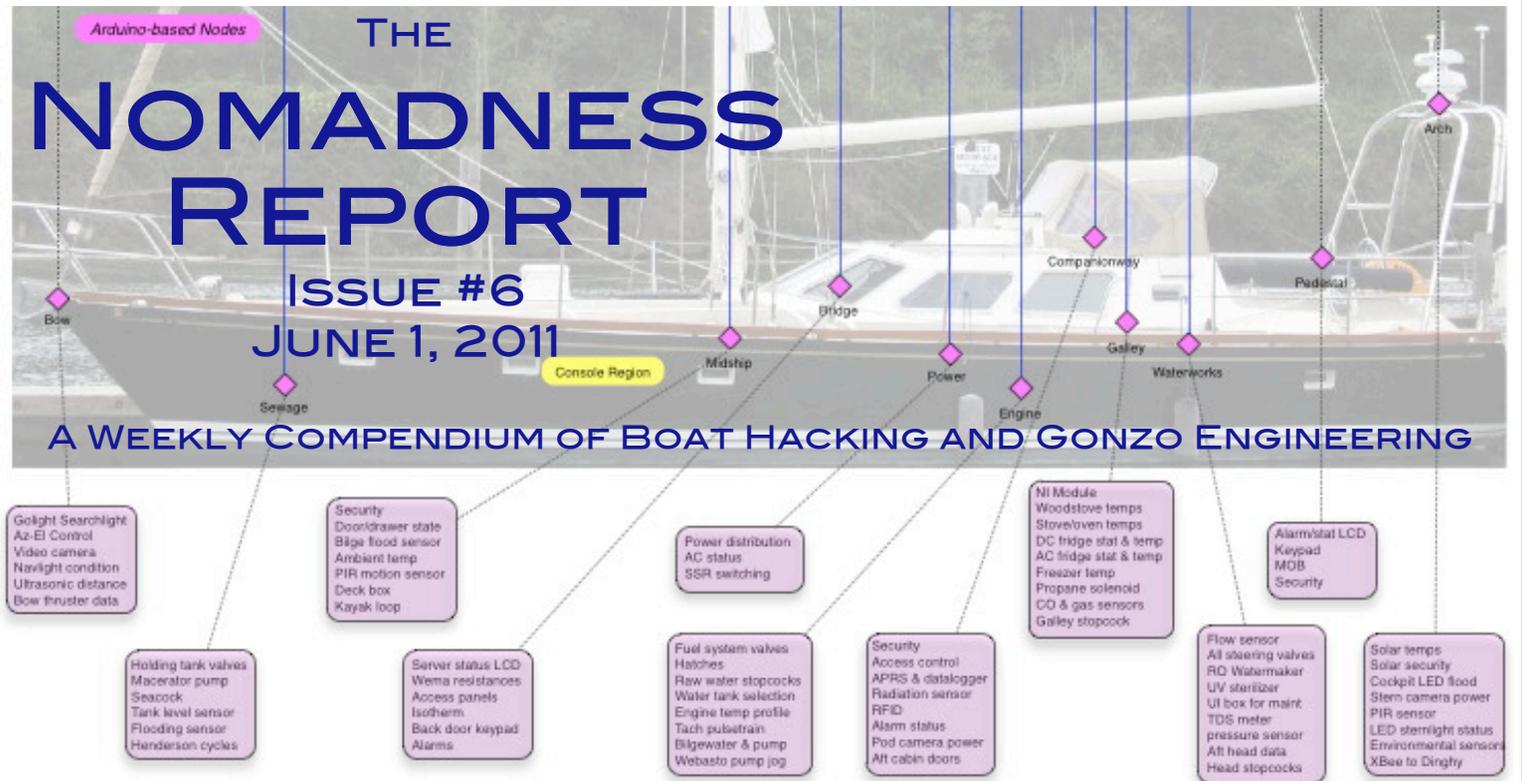
-Steve

nomadness
CAMANO ISLAND, WA

THE NOMADNESS REPORT

ISSUE #6
JUNE 1, 2011

A WEEKLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



THE EXTERNAL SUBSTRATE

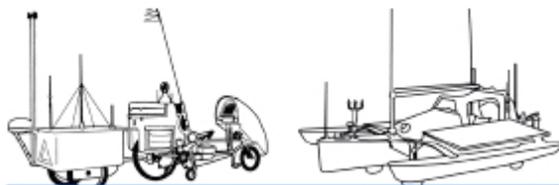
This issue looks at the physical context of this massive project... the boat herself. After a few false starts and near misses, I chose a robust and well-respected steel monohull, accepting an unfamiliar set of maintenance issues in exchange for the knowledge that the most fundamental structural components are sound. Next week, I'll present a walkthrough of the interior, with special attention to the area that will become lab and console space.

We also devote a page here to a unique solution to the curtain problem, relate a few lessons about boat projects, discuss management tools, and introduce a favorite piece of latching hardware.

I have been gratified to see new subscribers steadily arriving, since writing and producing this takes about one full-time day a week. Thanks for helping move the project forward, and please don't forget my offer of 5 free issues for any associate who subscribes.

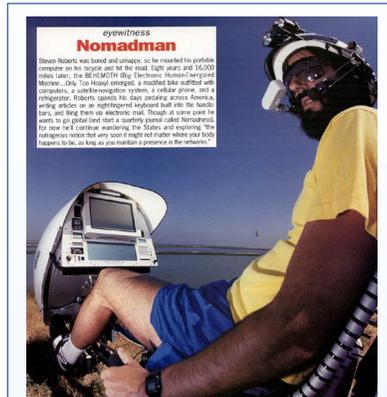
Also, I welcome questions or comments... I should be adding a letters column Real Soon Now!

Cheers,
-- Steve



Nomadic Research Labs

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microship.com



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Photo: Details Magazine, circa 1992

MAGNETIC CURTAINS

Privacy in the Fishbowl

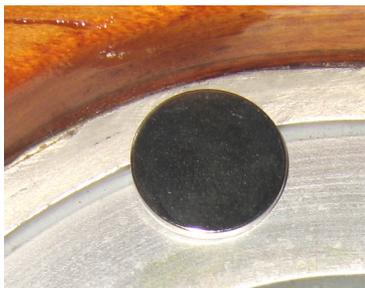
One of the early discoveries with *Nomadness* was that the pilothouse is a greenhouse on sunny days. Those low-angle raked forward windows may look sleek, but they are a solar oven... and too exposed to dock walkers.

Normal curtain hardware would have been challenging, requiring tracks on the sides or some other method of preventing sag. I considered running Velcro all the way around, but that would be forever annoying.

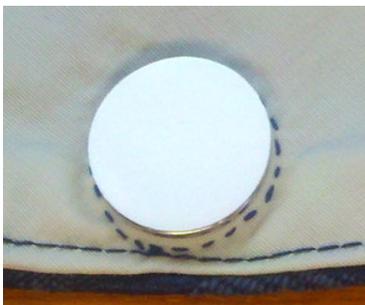
What I really wanted was a window treatment that would go away when not needed, but otherwise provide good and attractive coverage. How about strong neodymium magnets?

These are amazingly powerful, especially the ones graded N52. My favorite supplier is [K&J Magnetics](#), and they have everything from micro magnets to ones that will crush your hand (seriously). For the curtains, given the size of the aluminum framing around the windows, I chose the [DC1-N52](#) (3/4" diameter and 1/16" thick), which at the time were a little over a buck apiece.

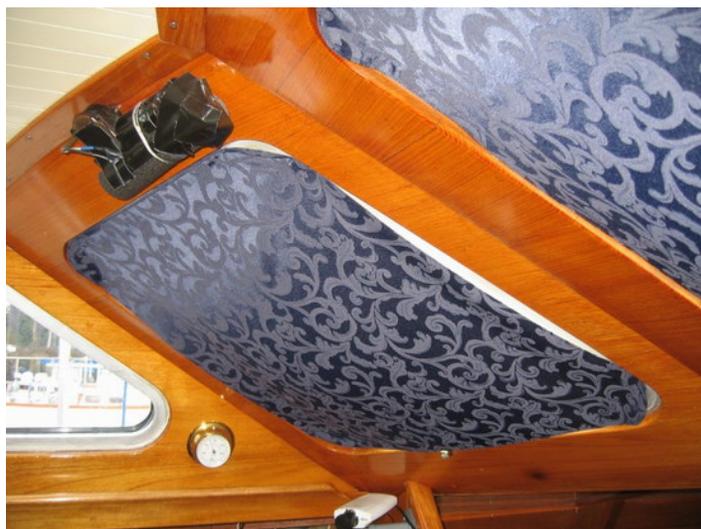
Attaching to the window frame wasn't quite as trivial as I had imagined... both kinds of double-stick mounting tape I tried tend to either weaken over time from condensation and solar heat, or fail to grip reliably where the surface is stepped (as in the photo here, mounted with a pre-formed disc of polyurethane foam tape - McMaster-Carr #76535A76), so I'm about to bed them all with some kind of goo like 3M 4200 that should be much more permanent.



On the curtain side, the trick is hand-sewing the magnets, since machines will grab them and not let go. My partner Kirsten used our White sewing machine to "lamine" Solarplex exterior UV-resistant fabric and blue patterned Jacquard, working from paper templates lifted from the windows last year. Before closing, she dropped magnets in the specified locations and hand-stitched around them. This photo shows one of those, with the mating magnet in place prior to attachment. They're pretty much self-fixturing, so this part was easy!

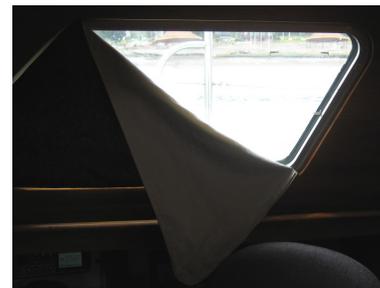


Although it technically doesn't matter, I recommend matching all the



polarities... they behave more logically if all the poles face the same way. I made a little test fixture that Kirsten used to check each one before sewing it in place.

The net effect is quite clean, even with a little inevitable sag and gapping along the edges. There is no protruding hardware as is common with curtain rods, and when they are not in place, the magnets are hardly noticeable.



One of the best parts is that any corner can be opened to peek outside or control lighting, as in the photo above. The cabin is noticeably cooler on sunny days, and reduces exhibitionism at the dock (that was getting really annoying as I started living aboard). The Solarplex outer layer should last for many years... it combines tough Cordura and high filament-count Supplex yarns.

I'm fabrics-challenged, and am very grateful for excellent help on this project from Karen Kelly (forward curtains), Sky Myers (templates), and Kirsten Hansen (side curtains).

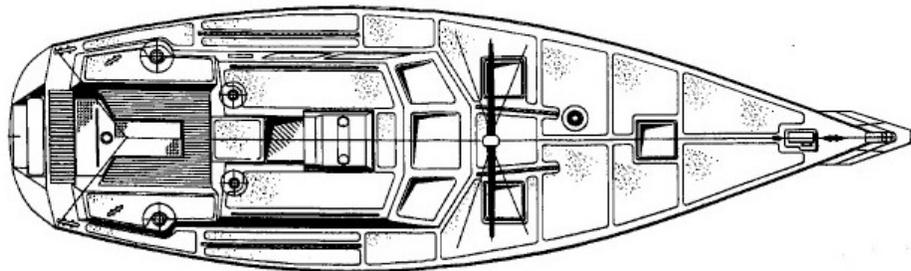
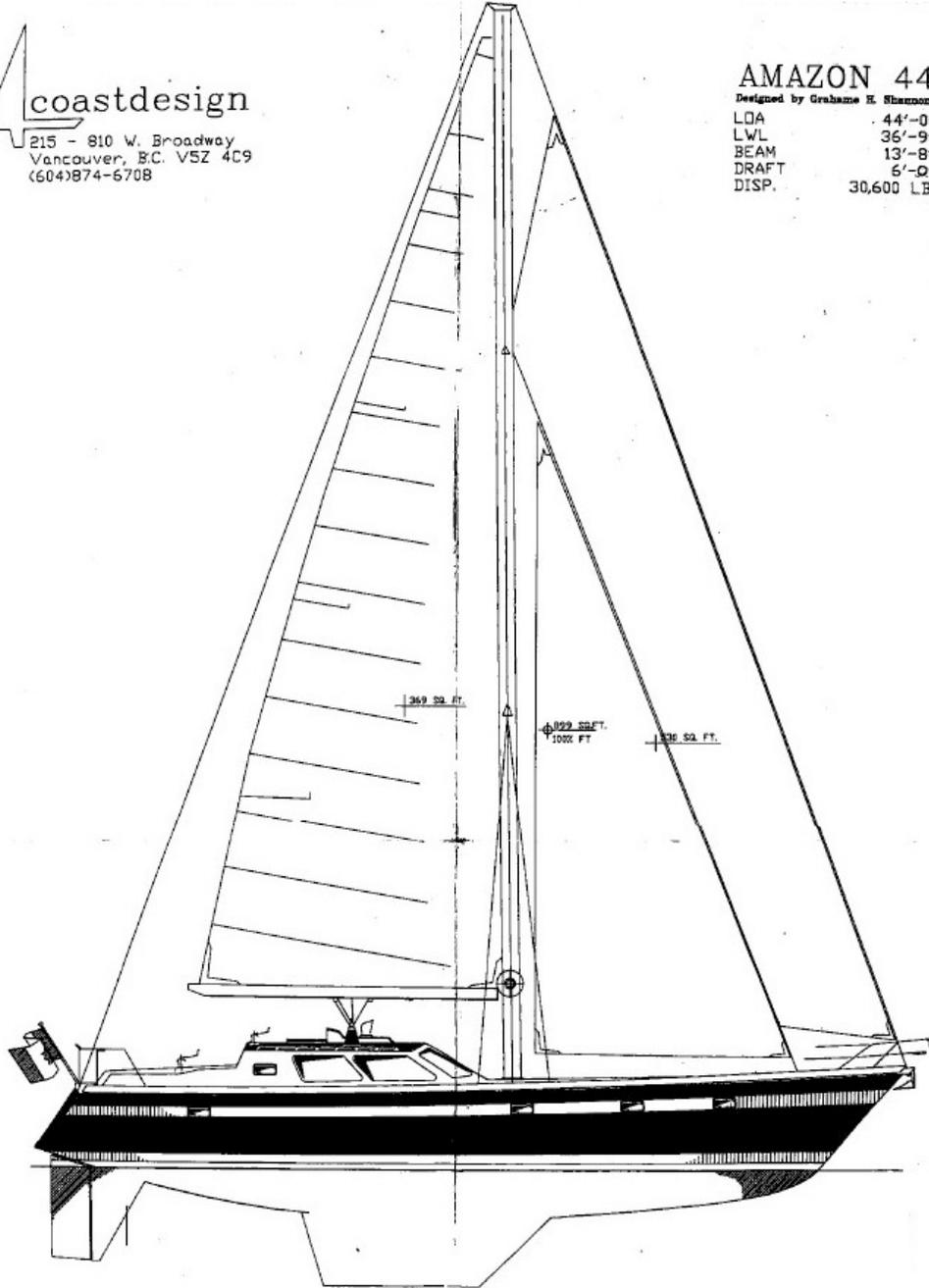


NOMADNESS SUBSTRATE

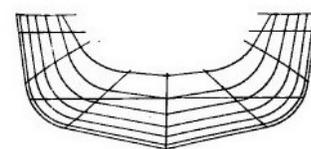
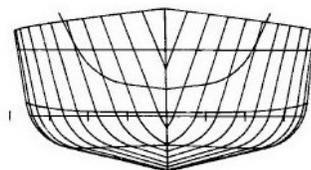
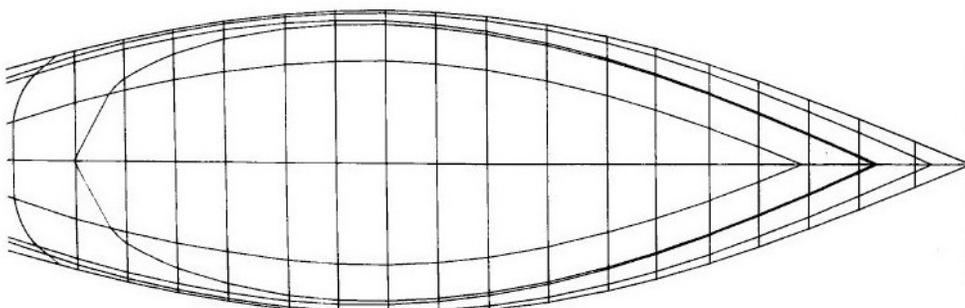
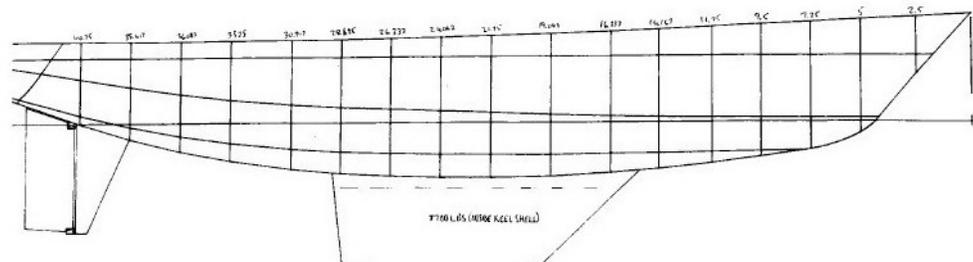
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Vancouver, B.C. V5Z 4C9
(604)874-6708

AMAZON 44

Designed by Grahame H. Shannon
LOA 44'-0"
LWL 36'-9"
BEAM 13'-8"
DRAFT 6'-0"
DISP. 30,600 LB.



NOMADNESS SUBSTRATE



A Quick External Walkthrough

Before we delve into system-integration and console-packaging issues, it's worth taking a few minutes to introduce the boat... we're already at Issue #6 and have only briefly touched on the substrate (Issue #4, page 2, yearning for a bow thruster).

Nomadness is a 44-foot steel raised-salon pilothouse cutter built in 1987 to the Grahame Shannon "Amazon 44" design by Dieter Pollack of SP Metalcraft of Vancouver, BC. She had a major refit in 2002, and has covered both coasts of North America including two transits of the Panama Canal. I believe I am the third owner.

Steel boats cover a very wide range, and to some extent have gotten a bad rap since so many are homebuilt... with a corresponding uncertainty about the quality of materials, welds, and coatings. Even insurance companies are somewhat wary of them, and I had a thorough survey before taking the plunge. The plating thickness is .2" with very stout structure and deck backing, and the foamed insulation stops properly at the waterline. (Foam all the way to the bilge is deadly, since it can trap moisture; steel boats, as fiberglass owners will happily tell you, rust from the inside out.)

Nomadness was built in a real shipyard, and has been well-maintained with proper coating systems above and below waterline, along with careful attention to galvanic action. The rig includes a Hood

in-mast furler that allows all sailing operations to be handled from the cockpit... with massive Barient 35 winches for the furling headsail. She's technically cutter-rigged, though the inner forestay is currently stowed along with the corresponding jib.

Ground tackle includes a Lighthouse 1501 windlass, 300 feet of chain, and a 65-pound Bruce claw anchor... a nice combination that has only [failed me once](#) (I also carry a smaller stern anchor as well as a backup).



NOMADNESS SUBSTRATE

She has a pilothouse, which is a wonderful thing, allowing control from inside when the weather is unpleasant. But it's a compromise; although the design is sleek and sexy, visibility through those low and sharply angled forward windows (about which I complained in the curtain discussion) is not always clear enough to inspire confidence. With radar and the upcoming suite of video cameras, though, I suspect that will become less of a concern... and when things are tricky, like picking my way through a sea of fishing floats, I just saunter to the bow with the Bluetooth wireless remote for the Simrad autopilot.

The default operating position is the outside helm back there at the stern, and the big change coming there is a 360-watt solar array that interfaces with the stout radar arch. This will also add antenna mounting space, increase the sense of security, and provide weather protection for the helmsman... not to mention a major power source for the Outback charging system when off-dock.

The aft cockpit, like everything on a boat, is a trade-off. The foot well introduces serious head-bangers in the aft cabin (better known as "the cave," no longer my preferred sleeping spot), and there is very little exterior stowage space on this boat... just a shallow lazarette under the aft seat at the helm. A custom deck box is about to be added on the foredeck (further impacting visibility from below, already hampered by mast, kayak, and other gear). The later addition of a hard dodger will have the effect of adding an "upstairs" pilothouse, also increasing stowage and living space.



The arch is a key structure, and carries the dinghy (*Nomadling*) that hangs from the davits whilst underway:



That dink is a Gig Harbor [Navigator](#) with [forward-facing rowing](#) system, a surprisingly capable sail rig, and a pair of [Dinghy Dogs](#) to provide flotation when most needed... she is quite a delightful little sprite.

I also carry a [Hobie i12s](#) inflatable pedal-kayak, which I quite adore... but as any cruiser will tell you, the dinghy quickly becomes the "family car." Most folks have a motor affixed to the transom for added practicality, and I have a little 2.5 horse Yamaha... but really, rowing is less hassle. The motor spends most of its time clamped to the stern rail.

The current dodger (that tan cover over the companionway, under the boom) is a beautiful piece of work... but tired. I've been eyeing that space for its potential in mounting antennas, lights,

cameras, sensors, solar water heater, and other equipment... so along with the big solar project at the arch, I am planning to replace the dodger fabric with sheet stainless. With those two structures in place, the next step will be a deployable cockpit enclosure, creating an exterior "room" on the boat when conditions warrant.

Much of this project involves surgical enhancement or modification of existing structures, and it is difficult to begin such invasive operations. For 3 years I was stopped by logistical issues, but at last I'm living aboard with development facilities nearby. Although it is excruciating to fire up a Sawzall in the presence of fine teak/holly joinery, that's the only way we'll get this starship off the ground...

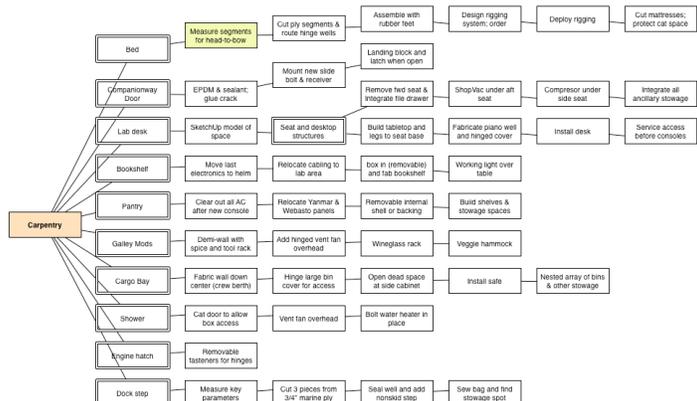
In the next issue, we'll look at the interior and see how we're going to shoehorn a lab onto the boat!

THE ZEN OF BOAT PROJECTS

I'd like to share a few lessons I've learned about boat surgery. Some of these are in the category of "expensive education" and others are just part of the whole [gonzo-engineering](#) ethos. This is updated from my 2009 blog post on the subject...

1. **Never hire a guy who hates his work.** I'm still fixing messes left by the plumber-from-hell, and there were lots of clues while he was on the job that should have been grounds for termination. Example: instead of using the correct bolts and nuts for the SeaLand inspection plate, he just shot in some sheet-metal screws, distorting the polyethylene Ronco tank material, with one screw even penetrating the sidewall of the oversize cutout... creating a gap that leaks under pressure and insufficient material for a proper re-installation. This hotshot charged me \$80/hour. Hiring him was a mistake, even though some of the tasks were intimidating and I felt I needed his skills... ever since, I have been chasing leaks (two hoses, the access plate, and a botched Spinweld) and otherwise cleaning up after him.
2. **DIY should always be first choice**, with the hiring of professionals limited to cases of esoteric knowledge, true gurus, or jobs requiring expensive capital equipment. As I proceed with the geeking-out of the ship, my casual "business model," is publishing the designs (and in some cases assembling kits). I think a lot of boaters are coming to the conclusion that most of this is *not* rocket science, and the economy has a lot to do with it...
3. **To-Do lists are fractal.** The closer you zoom into one item, the more it expands into a cluster of component items. I try to anticipate this with what I call "CDTs," or Clearly Defined Tasks. Writing these out ahead of time may seem like over-detailing, but pays off when it helps avoid gross underestimation of time and costs (you also get more-frequent happy moments of checking something off, even if you do something that's not on the list, then add it and cross it off... although switching pens in between is getting pathological).
4. **Project management tools can make or break a job.** I like [OmniFocus](#) since you can list by projects and then review by contexts (like, "what else do I need to do now that I'm aboard with oscilloscope in hand?"). [Scrivener](#) is useful for keeping the sprawling collection of design documents in one cohesive environment... before that, I had stray files everywhere. I've just begun using graphic outlines in [OmniGraffle](#), letting me visualize the tree structure of project categories. And for lab notes on paper, I prefer the beautiful [Maker's Notebook](#).
5. **If a project requires (n) components, there will be (n-1) units in stock** (from an ancient collection of Murphy's laws, circa 1969). It is really worthwhile to buy in bulk... and besides, you end up with repair inventory and trade goods. For hardware, [McMaster-Carr](#) is spectacular although not cheap... their extensive online catalog eliminates the need for that very hard-to-get yellow book that was indispensable in industry for ages.
6. **Tool duplication between home and boat is unavoidable.** You'll end up needing 'em anyway. Expensive tools are usually good investments, though they sink just as fast as cheap ones (don't be too macho to use a lanyard when leaning over the rail). The Li-Ion Makita [LXT](#) power tools are awesome... I love them, along with the [best drill bits](#) I've ever owned, Milwaukee Cobalt. This felt like a splurge at the time, but has been a winning investment.
7. **Document, document, document!** Buy a labeling machine and ID every cable as it is identified. Take the time to do good drawings (I use [OmniGraffle Pro](#) for overall diagrams, and [Eagle](#) for detailed schematics... and have settled on an 11x17 standard drawing size). Start a binder for known-correct information that you will want to be able to find again... sprinkled throughout project notebooks and random scraps, it gets lost. Dedicate portable file boxes to manuals and individual projects. Use your digital camera to chase otherwise invisible mysteries, and save the images. Take photos before closing off an area so you will know later where *not* to drill.
8. **Save labeled core samples from hole-saw adventures.** Just... because.

SPEAKING OF PROJECTS...



Southco Soft Draw Latches

These are one of my favorite tools for holding things shut... they come with three flavors of mating catch, and have a satisfying hysteresis from the stretchy rubber. They are a little over 4 inches long, and cost about \$13 each from [McMaster-Carr](#). The manufacturer's product page is [here](#).

In the photo above, they are holding a couple of adjacent drawers closed... one of which is heavy with tools. The original plastic thumb latch had grown weak, and one day on a pounding port tack the drawer flew open and shut repeatedly with loud bangs until we managed to clamber down there and tape it shut.

Carpentooning

The drawing above is one of a whole set of graphic to-do lists that have fallen out of my obsession with the 11x17 project binder. Each is a broad category of jobs (this one is "Carpentry"), with the column of double-outline boxes being sub-projects (bookshelf, pantry, companionway door, bed, shower, etc). The regular boxes are bite-sized tasks... not as fine-grained as the CDTs mentioned on the previous page, but things that I can think about as single, focused jobs. When one is done, I get the fun of coloring it.

Note that branching is possible, as in the lab desk thread that forks into desktop fabrication and modification of supporting structures. The above is not intended to be readable in this PDF - it's just to show the management tool, which is native to OmniGraffle.

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Cheers, and thanks for subscribing!
-Steve

Subscription Administrivia

As new subscribers come aboard, I have been emailing collections of back issues. At some point, I'm going to have to actually start subscriptions at something other than #1... that event will occur quarterly, when the previous 13 issues will be collected into a print volume and eBook. It will simplify bookkeeping, too...

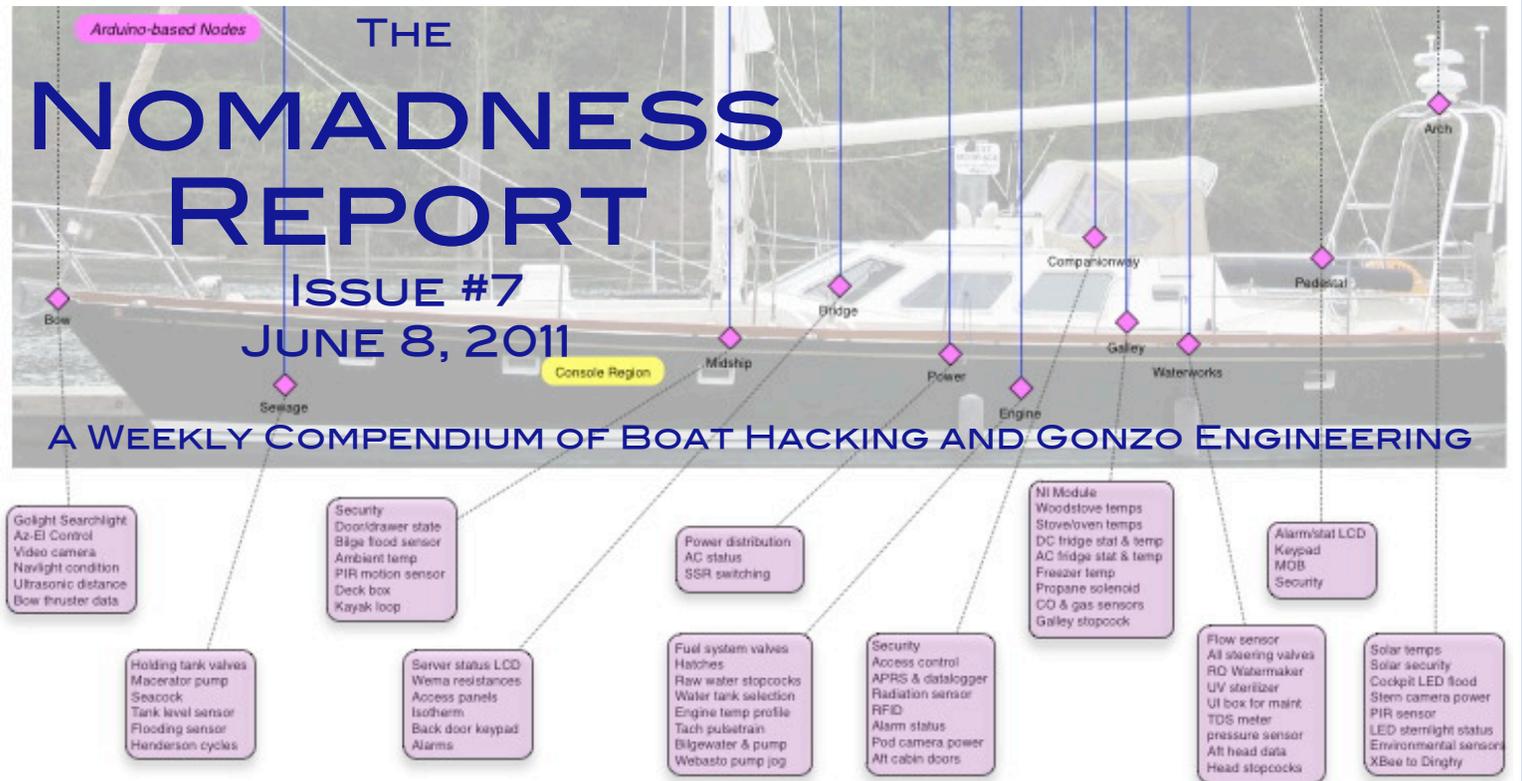
For now, regardless of when you subscribed, you should have all issues to date, with a renewal at #52 or so...



THE NOMADNESS REPORT

ISSUE #7
JUNE 8, 2011

A WEEKLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



INTERNAL SHIP WALKTHROUGH

In this issue, we take our first look at the boat's interior... classic wood joinery and a beautiful, almost austere layout that is a natural backdrop for gonzo engineering projects. She's not cushy at all, and although that is sometimes annoying, it lends itself well to gizmology (while quietly enforcing a sense of quality, since slapdash packaging would clash).

We stroll slowly through the pilothouse, looking at the overall view, wood stove, galley, and piloting console... then step below into what is about to become the lab and sketch some of what lies ahead. There's more, but we'll get to it another time.

We also devote some space to reverse engineering, which will be an ongoing background task for a while, and pay homage to the *Microship*, which occupied a decade of my life before I turned my attention to boats big enough to live aboard.

Finally, we close on a personal note... with some words of appreciation for my engineer/sailor dad who left us six years ago.

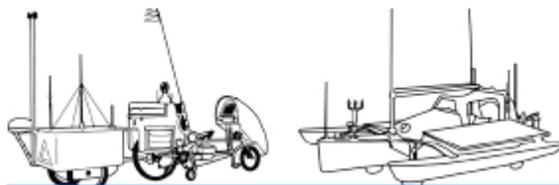
-- Steve



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Photo aboard in 2008, wearing the awesome [Seattle Sombbrero](#).



Nomadic Research Labs

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REVERSE ENGINEERING

Sleuthing...

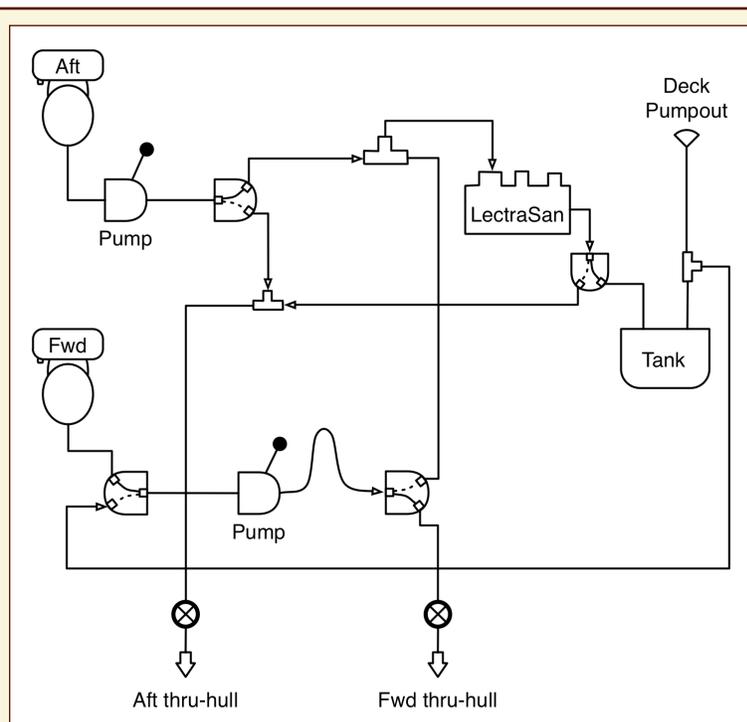
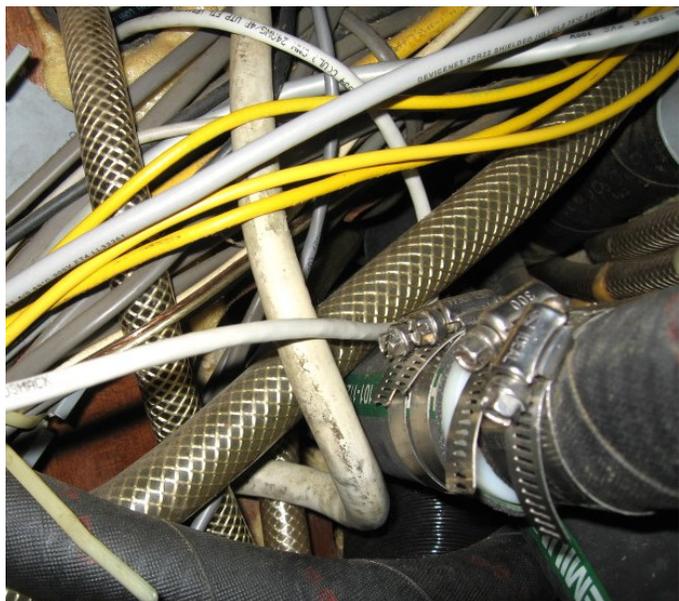
In Issue #4, I spoke of my new [Brother 11x17 printer](#), which is turning out to be excellent. Along with a suitable [binder](#) and a batch of [paper](#), I now have the tools in place for a proper documentation library. This will not only keep me sane when trying to debug problems, but will make life easier for whomever sails away in this ship long after I'm gone.

It's not easy, though. With the exception of some quarter-century-old drawings that came with the boat (still marginally relevant here and there), I have nothing to go on but what is physically in place. Typical of most boats, this was not done with any thought for future comprehension, so there is no labeling... and lots of nigh-inaccessible jumbles of inscrutable tangles.

Of course, this is unacceptable, so an ongoing background project here is the decoding and documentation of existing systems. This involves not only drawings, but adding corresponding labels so the *next* time I'm crawling around in there it will make sense.

The most basic technique is simply starting at one known object and physically following cables and hoses to see where they go. The other night, Kirsten and I did this with the raw-water system, following every hose from the two Groco strainers to their destinations... capturing it all in a hand-drawn sketch that has since become a proper schematic in the new binder.

That one was relatively easy. Ahead loom the nightmares of abandoned wire runs, convoluted circuits, repurposed cabling, mystery splices, and more... all of which must be clear before I start adding my own bundles of USB, coax, power, and network cabling! In future issues, I'll share some techniques for wire-chasing and reverse engineering..



Bizarre Plumbing

I'd like to sit down and have a long chat with the guy who designed the sewage system that came with Nomadness... it is arcane and bizarre. That tank is only good for about 6 flushes, and if you think through those four Y-valves, you can see that the system can be configured to:

- flush either head directly overboard*
- flush either head through LectraSan*
- route LectraSan output to tank or overboard*
- use forward head pump to empty tank*

This all sounds logical, but practicality is hobbled by the long hose runs, 16 non-intuitive combinatorial possibilities of Y-valves, tiny tank, and failure-prone LectraSan processing system (40 amps to sterilize poo in saltwater, making it legal to discharge in many areas).

In 2008, I paid too much to a sloppy contractor to break this system in half and create a basic system forward (then I chased his leaks for 2 years). The old craft is still in place, and I'm contemplating tossing it all in favor of a [Nature's Head](#) composting toilet. That would be ironic, since the adjacent wall will carry the Waterworks system, an extravaganza of complex plumbing.

I just hope that in 30 years, some future owner is not publicly chastising "that crazy guy" who built weird stuff back in 2011! Hence the careful documentation...

MICROSHIP MEMORIES



There is considerable history behind this *Nomadness* project; it did not just spring fully-formed into existence. For 8 years beginning in 1983, I pedaled a [computerized recumbent bicycle](#) around the US, then fell in love with multihulls and launched a ten-year project to build the [Microship](#). This migrated through three labs: 2 years in the electrical engineering department at UCSD (San Diego) as a context for student projects, 2 years in a building sponsored by Apple in Silicon Valley, and 6 years in a dedicated 3000 square-foot building in the woods of Camano Island.

Typical of many homebuilt boat projects (the average completion time of which is 137 years), by the time it was “done,” my needs and desires had changed. This amphibian pedal/solar/sail micro-trimaran is a very athletic machine, first conceived as the aquatic equivalent of my *BEHEMOTH* bicycle... and with involvement from some of the best marine architects in the business as well as a massive injection of hands-on engineering talent, it’s a serious tool for exploration of coastal and inland waterways. But I had to admit that in my increasingly creaky 50’s, the planned 14,000-mile *Microship* expedition was becoming ever less likely.

I moved on to bigger boats, first with the Corsair 36 “*Microship*-on-steroids,” and now with its polar opposite: an 18-ton steel monohull. I hope a trawler isn’t next, but I see how that happens!

The *Microship* is still in the Camano Island lab, and is looking for a new skipper. This is not easy to find, since if all someone wants is a little beach tri, there are many cheaper and simpler alternatives. There is a limited market for expensive one-person trimarans that fold for land transport, especially with yacht-scale engineering that prices it up with decent family cruisers.

There’s a ton of information about this boat online, so I won’t consume space here with details... basically, it has a 93 sqft roller-furling sail rig, a pedaling system that can sustain 3-4 knots, electric auxiliary propulsion with a 480-watt solar array, deployable landing gear with hydraulic steering, retractable mesh recumbent seat to allow sleeping aboard, hydraulic rudder controls, sealed compartments for unsinkability, and more.

More about the design is on my [website](#), including a [spirited retrospective](#) of the project and a [photo album](#). If you know a technomadic geek who could make use of this machine, please put us in touch!

INTERNAL SUBSTRATE

Last week, we took a look at the *external substrate*, a moniker that elicited a few chuckles (most people call these things "boats," apparently). In this issue, I want to show you the interior, with particular attention to the region that is going to be devoted to geekery.

Nomadness (a steel Amazon 44) is rather unusual in that she has a sort of classic wooden austerity... rather hard-edged as opposed to soft and cushy inside. I find myself annoyed by this sometimes, even though it is one of

the things that initially appealed to me: a motif that already felt like a "substrate" instead of something cozy that would have to be ripped out in order to add such geek niceties as lab benches and communication consoles. On the other hand, it's not particularly inviting to guests, or even a couple; the one big bed (more than king size, which is a lot of bunk!) is underneath the aft

cockpit, translating into head-banging low overhead and an oppressive sense of crowding. I've moved to the Vee-berth in the bow, just for nicer *feng shui*... even though it is much smaller.

I don't actually know anything about all that, but there *is* a feel to such things, and it profoundly affects the human psyche, from relaxation to productivity. One of the huge contextual aspects of this project, therefore, is to remain aware of this and integrate it into design decisions now (while it is still possible).

Unfortunately, it's rather hard to quantify, and I'm also constrained by what is already in place.

So as with most of my projects, the guiding principle is intuition... how it *feels* as opposed to how it fits together in a CAD system. Actually, I do use CAD extensively, but in my case it has a different meaning: Cardboard-Aided Design. Before doing surgery in the new lab region (forward and to port in the photo below), I'll hot-glue a big life-size model and play with it for a while. Ideas that I think are well-refined now will give way to issues of comfort, serviceability, and *vibe*.



We might as well start with this photo, a wide-angle view from the companionway... just as one steps inside from the cockpit. This was taken by the [Swiftsure](#) broker before I acquired the boat, and is thus missing my wood stove, new electronics, and pervasive surface clutter.

More detailed photos of individual regions will follow in the next few pages along with discussion of impending changes, but let's take a quick look around from here. When you come down the companionway

Qi rides the wind and scatters, but is retained when encountering water.

steps, you land in a big open space that combines piloting, engine room access, power management, nav station, and galley to port. Behind you through a door to starboard is that large but low sleeping cabin called the Cave... now becoming split into Cargo Bay and Crew Berth. Forward and down is a hallway with dinette and entertainment area (along with a shower cabin and washer/dryer); further forward still is the V-berth cabin with head compartment.

The galley is immediately out of frame to the left, and in addition to that marginally adequate power hog of a DC refrigerator, there is a powerful AC cold-plate system with a top-loading fridge under the counter and a top-loading deep freeze under the chart table. It works so well that in the 2.5-month 2008 shakedown cruise, we had no trouble keeping staples like Häagen-Dazs, bagged ice, and frozen fish in stock.

The "nav station" forward of the galley came with vintage electronics, but is going lower-tech, devoted to nautical bookshelf, office, and sextant stowage. All major geekery is moving to the piloting station to starboard, or into the lab/console area forward.

The open central floor in the photo consists of two large hatches, one each for the main engine (Yanmar 4JH-DTE 77-horse turbo diesel) and the 7.5-kilowatt generator (driven by a Yanmar 3GM). Serviceability is not great, and I've made it worse with the addition of a wood stove.

Let's zoom in on some details, starting with that.

INTERNAL SUBSTRATE

Wood Stove

This sleek heater is the [Little Cod](#) from Navigator Stove Works, based on Orcas Island in the San Juans (the picture at that link is another view of my stove, just after installation). In this photo, we are looking back at the companionway steps, where we were standing in the photo on the previous page.

I wrote a rather [detailed blog post](#) about its installation back in 2008, so I won't spend time on it here... all I'll add at this point is that it works beautifully (sometimes TOO well!), quickly heating the boat with a small amount of scrap lumber or proper firewood. The platform is laser-cut stainless, a heat shield protects the counter structure, and I added a cage made of standard 7/8" rail hardware to provide safe handholds under sail and keep bodies from hot iron when stoked.

At the dock, I often use an oil-filled electric radiator, and there is also a Webasto diesel heater (which currently needs its fuel line burped). The beauty of the wood stove is that it can work with found fuels... if we're ever in survival mode, this is in the same category as watermaker, solar panels, fishing gear, and sails.



Galley

A major center of daily activity, of course, is the galley... mine is adequate, though not generous with either human or counter space. It's just to port of the companionway steps, and in the photo above (taken before wood stove installation), you can see the double sink, gimbaled propane cookstove, and top-loading AC refrigerator.

There really isn't adequate stowage in the galley itself for stores and cooking tools, so the former are in a nearby drawer (as well as a future pantry in the area about to be vacated by the old AC panel) and the latter are scattered here and there. One fairly urgent project is a little "demi-wall" at the back of the counter, carrying spices, well-secured knives, and other frequently used tools.

This was built as part of a major refit in 2002, and although beautifully done with first-rate equipment, it has created some major serviceability issues. Things that are known to fail (water pumps and refrigeration) require either wee contortionists or implements of destruction... so when I do the Waterworks project in the aft head compartment on the other side of the sink wall, I'll open access and relocate a few critical items.

Moaning aside, it's a capable workspace, and is supported by robust systems. In addition to the refrigeration mentioned on the previous page, an Isotemp water heater (recently installed behind the shower) makes doing dishes tolerable... and there are foot pumps for both salt and fresh water in addition to the pressure system.

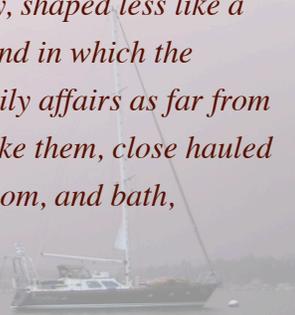
My biggest complaint is low overhead over the stove, which feels a lot like the aft cabin, along with the awkward sliding cabinets on the wall behind that tend to be relegated to seldom-used supplies. Boats, being curvy, are rife with trade-offs when it comes to usability and stowage space!



INTERNAL SUBSTRATE

If a man must be obsessed by something, I suppose a boat is as good as anything, perhaps a bit better than most. A small sailing craft is not only beautiful, it is seductive and full of strange promise and the hint of trouble. If it happens to be an auxiliary cruising boat, it is without question the most compact and ingenious arrangement for living ever devised by the restless mind of man—a home that is stable without being stationary, shaped less like a box than like a fish or a girl, and in which the homeowner can remove his daily affairs as far from shore as he has the nerve to take them, close hauled or running free—parlor, bedroom, and bath, suspended and alive.

- E.B. White



Piloting Station

This is an area that is changing as we speak, bringing a lot of tools up to date. The old photo below is the center of operations, with basic nav/piloting, engine control, radar, and power management hardware. Actually, I prefer driving the boat from the outside helm, but having an inside steering station is wonderful in the Pacific Northwest (that big joystick controls a hydraulic pump that parallels the wheel, and there is also a Simrad [autopilot](#) with Bluetooth remote that drives the same huge actuator).

The classic Furuno radar is a 48-mile, open-array unit... a real lifesaver in the fog. There is much newer stuff out there, and maybe someday I'll upgrade, but the old-fashioned part of me is comforted by minimizing single-point failure potential when it comes to critical nav systems. The old Robertson autopilot in the photo (to the left of the radar) is long-gone, however, and when the joystick moves up to the wood framing, that open space will carry a chartplotter.

The power panel is also undergoing a major revision, with all the little stuff at the bottom already obsoleted, and the Xantrex panel at lower right long since replaced by much better [Outback](#) gear. The breaker panel is on the way out in favor of a more densely packed AC and DC control center based on [Bluesea](#) products. This is another

of those areas where the original installation is a serviceability nightmare... that panel on the right hinges UP, requiring an awkward twist when wiring. The new one will hinge down, matching the design of the piloting panel on the left. Behind both are generous equipment bays with cabling, power distribution, inverter-charger, isolation transformer, and so on.

The original nav station across the pilothouse still carries instrument displays (speed, depth, wind) along with a marine VHF radio, and those are migrating here in order to keep all attention and control in the same general area. It will be very dense by the time it's done, yielding a focused piloting console functionally distinct from the lab region below.



THE GEEK PLAYPEN



If you step forward from the pilothouse where we've been all this time, you pass into what might normally be called the saloon. This came with an attractive but uncomfortable dinette on the port side, with deep drawers underneath the raised platform supporting the table and lots of stowage under those cramped seats.

Across the aisle is a TV with related equipment in a cabinet and stowage behind, an excellent set of drawers, a washer-dryer covered by a pair of doors, and a dedicated shower compartment hiding behind the mast partner. In the middle is a catch-all counter with no clear purpose, a bookshelf, and a very deep hole that goes all the way behind the TV to the bulkhead coplanar with the door to the next cabin.

This is my playpen.

I've started nibbling around the edges of a SketchUp model... though my kind of immersive CAD will ultimately be the design tool that shapes the final plan. Basically, this 8-foot segment of the boat will consist of a large desk filling that settee space above, with a mounted swivel chair about where the table is located.

The top of the desk will carry four sloping equipment consoles: systems, communications, audio/video, and lab instruments. These have hinge-down front panels and chassis slides for serviceability, and the one closest to us in the photo also carries an LCD monitor on a swing-arm to support piloting operations. At the forward end will be a miniature of the "wall of inventory" that's in my mobile lab, and possibly a [Makerbot](#) Thing-O-Matic along with the tools for toner-transfer printed circuit fabrication.

Embedded in the desktop will be a 56" well with folding lid, containing the digital piano. When the lid is up, it will become a full-length music stand, with the A/V console accessible at the same time (it carries an [Edirol M-16DX](#) mixer, chosen because the control surface is separate from the interface box bristling with cables).

The underside of all this is a little tricky, since I still need access to the stuff under the seats (including air

compressor and central shop vacuum, not to mention a key thru-hull for pumpout). At the forward end will be a file cabinet, but most of the other gappiness between desktop and seat substrate will be used for movable storage so I don't create the kind of serviceability problems that already plague the boat.

Across the hall, I'm not changing much other than the use of the bookshelf and stowage spaces. A wood machinists' toolbox will fill the upper shelf, and the lower one will store power tools (with the deep inaccessible space occupied by infrequently-used items in packs attached to tethered and labeled cords... an old kayak-packing trick). The counter top will be a standing workbench with vise and related resources.

This *Zone of Hackage* is the key to the boat's embedded geekery. There is very little overlap or redundancy between all this and the pilothouse consoles, and for the most part this region exists independent of ship operations. Yet it is the core of the project's mission, integrating the layers of added functionality that have led to friends quipping that this is "Starship *Enterprise* on a sailboat."

I must admit, it's kind of maddening to have all those other projects competing for my attention. Plumbing is entertaining, certainly, as are carpentry and cabling, but what I'm really aching to do is get on with gizmology.



A NOTE OF THANKS

A funny thing happens when I write these *Reports*... time falls away and I suddenly notice the page count. I still haven't told you about the PENFA suite, cargo bay, hydraulics cabinet, cable tunnels, or the 4U2PN2 system... not to mention the *real* ship infrastructure behind the scenes. We'll get to all that in time, but I mostly wanted to introduce the interior of the ship and help fan those flames of fantasy. This is the reason for the EB White quote a few pages back; it is passion that drives all this, and now and then I have to just kick back and sketch my vision of a future starship... ignoring, for the moment, the broken shower seat, mysteriously beeping Yanmar control panel, and the long list of sub-projects related to the new power distribution system.

While finding photos to include in this issue, I came across this one. It prompts me to take a moment to introduce my father, Edward Roberts, who passed away in 2005. He was a lifelong mechanical engineer, and an avid sailor for many years before the demands of a young family led to a reshuffling of priorities. I presented a collection of photos from his Star-racing days



back on Lake Erie, along with a few thoughts about getting to know our parents while we still can, in my blog post [Son of a Sailor](#).

He worked for General Electric all his professional life, and for many years was president of the Kentuckiana Section of the Society of Plastics Engineers. I find this mug poignant and fitting, and it holds my daily morning latte aboard *Nomadness*.

Ed is part of this ship in many ways, not the least of which is the value of our old family home that enabled the purchase. I was raised with constant exposure to tools and quality workmanship, along with a project focus. He would have loved this well-engineered boat, so I'll close with the line that ends the blog post linked above:

**Fair winds,
Dad...
and thank
you!**

-Steve



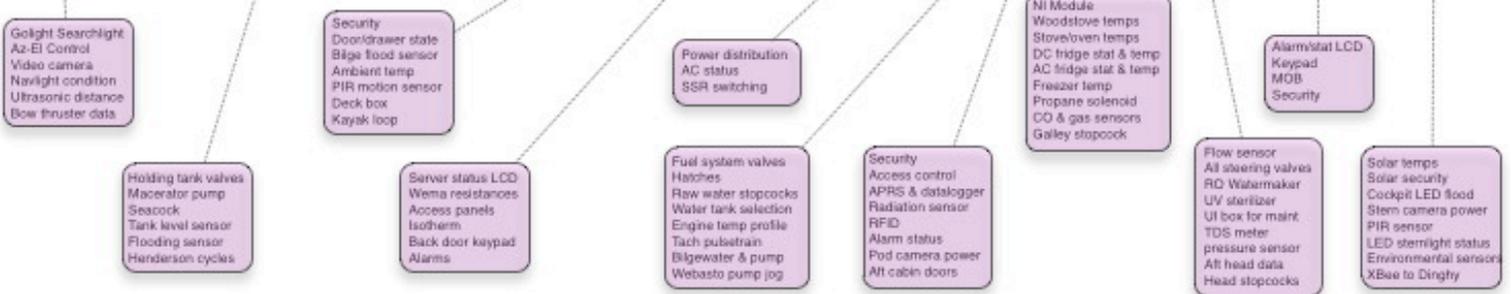
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*Do you have friends who would enjoy partaking of this weekly nautical geekery? For every new subscriber who mentions a referral from you, I'll extend your subscription by 5 issues. As I continue migrating my primary publishing context from the blog to the *Nomadness Report*, I need to get the word out... this is a great way to grow the network.*

Cheers, and thanks for subscribing!

-Steve

nomadness
CAMANO ISLAND, WA



SHORT SUBJECTS

Overload won this week, though I did do a burst of writing in the form of a [detailed blog post](#) about nickel generators (including this publication). In a self-referential twist, one of said nickel generators then demanded a huge block of my time, and now it's Friday night already.

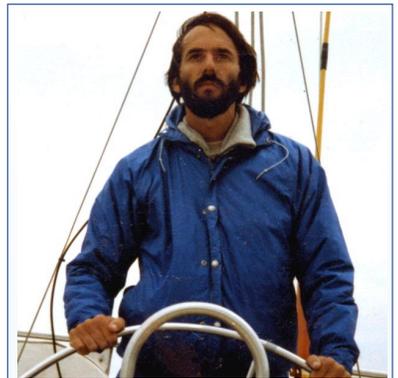
Since #7 was a standard deviation or so above mean issue length, I'm going to consider that sufficient excuse, *rationale* for compensating with a thin one this week.

We'll indulge in a couple of useful bits of terminology, address queued corrections, updates, and questions related to topics in previous issues... then wrap it up with a look at some substantial modifications to the cockpit and arch structures that got underway today after over a year of planning.

Our first quarterly compilation is about a month away, hopefully taking both eBook and print magazine forms. I still want to get moving on "subscriber of the week" features; a couple are in the pipeline, but if you'd like to say something about your work in these pages, please let me know!

And now, on with the quickie...

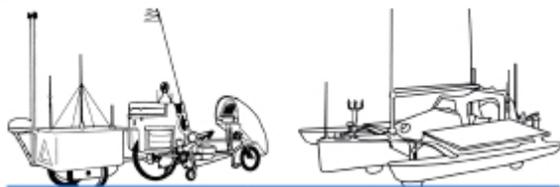
-- Steve



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The photo above was aboard the Awesome in 1984, sailing from Key West to Clearwater with my bike stowed below.



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A COUPLE OF USEFUL TERMS

Nickel Generators

Publication of this issue was delayed by a few days due to immersion in my other ongoing writing project... the [Nomadness Blog](#). I did a long and much-needed post about the decentralized business model that keeps this project afloat: a variety of small parallel "nickel generators" that collectively pay the bills. This is of particular interest to fellow technomads, cruisers, and others who need cash flow but don't want to get tied down to something immersive like employment or running a real company.

I won't replicate the content herein; you can read the whole post [at this link](#). But since this is more of a technical publication, I do want to mention one of the tools that is really helping (in addition to the ubiquitous PayPal): [Square](#).

With no up-front fee, no monthly fee, and only a 2.75% transaction fee, this provides a 1" square credit card reader that plugs into an Android or iPhone and accepts plastic. (For a slightly higher percentage, you can enter the numbers manually for online or phone orders.)

I haven't used mine heavily yet, but I love it... they even send a receipt to the buyer via SMS or email, and money appears in my checking account within a couple of days.

If you have a nomadic business, I recommend this... you can even charge for technical services on the dock without sending your buyer to a laptop in order to initiate a PayPal transaction.



Yak Shaving

This is such a universally useful concept, inevitably appearing in future issues of this publication, that I need to ensure it's part of our shared lingo.

Wiktionary offers this etymology: "probably coined by Carlin Vieri in his time at the MIT AI Lab (1993-8), based on an episode of The Ren and Stimpy Show." Basically, it refers to the all-too-common scenario of trying to solve a problem, which requires you to solve another problem, which can't be solved until you solve another problem... and so on, sometimes with such deep recursion that you forget the original problem.

My minor incidence of it today was needing to clear the arch in anticipation of a meeting with Rick Wesley (stainless welding guru), requiring me to lower Nomadling... which was difficult due to corrosion on one of the stainless ratchet straps. I lubed that, but launching the dink was then annoying since one of the [Dinghy Dogs](#) has a slow leak and hung in the water, so I tied it to the dock and started to pump it up... revealing a split in the hose associated with the cheap foot pump, prompting me to replace a sloppy repair job that I had done earlier with the butt end of a roll of tape. I chased down some fresh [Rescue Tape](#), did the fix, pumped it up, and went back to preparing the arch region for solar panel measurements.

This isn't the best example, since the side trip wasn't truly in the critical path to the central task, but it's fairly typical of a day working around boats (or computers, or network administration, or microprocessor design... or anything, really).

If you Google "yak shaving," you'll find [this entry](#) from Seth Godin's blog and [another](#) by Joi Ito. It's a handy term to keep around.

UPDATES ON PREVIOUS ISSUES

Curtain Magnets

In Issue 6, in the article about mounting curtains with neodymium magnets, I mentioned .75" diameter double-stick foam tape (McMaster-Carr #76535A76). I indicated that it was not ideal for stepped surfaces, and would now like to add that it is completely useless in this environment... the heat of a sunny day softens the adhesive. Not recommended.

Whiteboard Paint

In response to the special issue on the *Polaris* mobile lab (Issue #5), a couple of folks mentioned an alternative to the flimsy Melamine "Shower Board" that I used. It's called [IdeaPaint](#), and converts any surface into a dry erase board. I have not tried this, but will definitely do so the next time I find myself creating workspace (maybe even aboard, if there's a large enough blank surface in the lab region).

Mobile Lab Q&A

Issue #5 generated quite a bit of interest, and not surprisingly a few follow-up questions. Here are some from [Steve Stroh](#):

Do you leave it on wheels during extended parking sessions, or do you have jacks?

There are two struts that swing down from the stern, coarsely positioned by pins and external wood pads. I then crank the tongue jack to the point that these take a good bit of load, putting the whole thing on a tripod and making it less wobbly as I move around.

How much did it end up weighing?

I forgot to check, although a little back-and-forth with my [Sherline Trailer Scale](#) should give a reasonable approximation.

Can the generator power all the shop tools (one at a time,

obviously), or do you require shore power for anything heavy duty like a table saw?

I've been pleasantly surprised by the generator, which I've tested with table saw and drill press under load, as well as the air compressor. The system was designed to use 30A shore power, though at the moment the building it's in only has 15. It hasn't been a problem.

What was the provision for keeping the sawdust out of the microscope (kind of a big deal for SMT work)?

The microscope is always under a dust cover, and the plan (not yet implemented, but accommodated in the design) is a dust curtain between the power tool zone and the workbenches.

Have you done any work on the roof - antennas, etc.?

Only a dual-band (VHF/UHF) Larson antenna for the Icom 706mkIIG ham rig:



You mentioned that the batteries lived in the steel cabinets at the bow. Details? Venting?

At the moment, there are just two of the AGM marine batteries that I pulled out of the boat, and they are not significantly vented beyond random holes in the steel cabinet. They're not in great shape, but are adequate for now.

More Mobile Lab Thoughts

In Issue #5, I mentioned shipping containers, which are a remarkably cheap way to acquire high-quality secure enclosed space (albeit ugly, from some folks' perspectives). Here is an [Instructables article](#) on container acquisition.

Also, this topic came up on [Cruisers Forum](#) recently: how do you do dockside work on your boat? This covers a wide range, of course, but I mentioned having a mobile lab parked nearby and this sparked a few responses that have encouraged me to plan a follow-up article featuring other peoples' rigs.

If you have a mobile shop or other rolling workspace and would like to be part of this, please let me know!

To-Do List Management

While we're on follow-ups to items in previous issues, I want to mention that my graphic project-management outlines turned out to be more trouble than they were worth. While they definitely look cool and are fun to color, they offer no space for notes or embedded to-do lists... and they're a pain to edit. This is the sort of thing that would be perfect as a planning tool in a corporate environment, but not an agile management tool for a boat project.

My default was Scrivener, which I love for lots of reasons, but it's still tied to a computer and I'm moving constantly between boat, office, lab, shop, and home base.

I use an Android phone, and just discovered [Checkmark Pro](#). This looks like a nearly perfect to-do list manager, with easy category nesting, archiving, and export to HTML for display on a web page. I'm migrating to it now, and look forward to always having the full project state in my pocket, where I can easily incorporate new ideas. I'll let you know how it works in practice.

COCKPIT HACKS

I mentioned the meeting with my stainless welding guru today... this is the initiation of a long-awaited and rather huge modification to the boat. That arch on the stern is about to get a 420-watt solar array, split into two segments.

Aft, hinged and fixtured over the dinghy davits, is 240 watts (about 4x7 feet). I'll be able to fold the davits and drop the panel to reduce overall length when needed, and a moat around the perimeter will allow rainwater catchment.

180 watts extends forward, stopping just short of the boom and providing the roof of a cockpit enclosure (something that can vastly extend the livability of a boat in Northwest weather). This array includes a perimeter structure designed to support antennas, with cable raceways integrated into the arch and related structures.

None of this is quite optimal (nothing is); there will be partial shading from the radar, but there's enough overdesign (not to mention MPPT-tracking charge controllers) to make the best of the situation. The modules themselves are left-overs from the Microship epoch... 30-watt Solarex Ultralite units without any metal backing. At the time, I thought this was a good idea, and we laminated them onto custom folding foam-core substrates. But that was a huge design error; they got way too hot.

Here, the modules will be on sheet stainless, and I'm delighted to see them at last get put to use!

The other part of this upgrade will replace the existing fabric of the dodger with 16 gauge sheet stainless. This will support more antennas, as well as lighting, instrumentation, video, and a solar water heater to be integrated with the heat exchanger in the Isotemp (intended for engine coolant, but I don't trust that). The original fabric is a beautiful piece of work by Artful Dodger, but it's getting tired and the steel will fit the aesthetic of this boat more than a sewn replacement.

The front windows will become rigid polycarbonate instead of the typical fragile dodger vinyl... with the center segment able to open.

Other cockpit work includes a desperately needed helm seat, a pod for instruments at the steering pedestal, LED floodlights and video cameras, and a thicket of antennas... she might look a bit geeky.



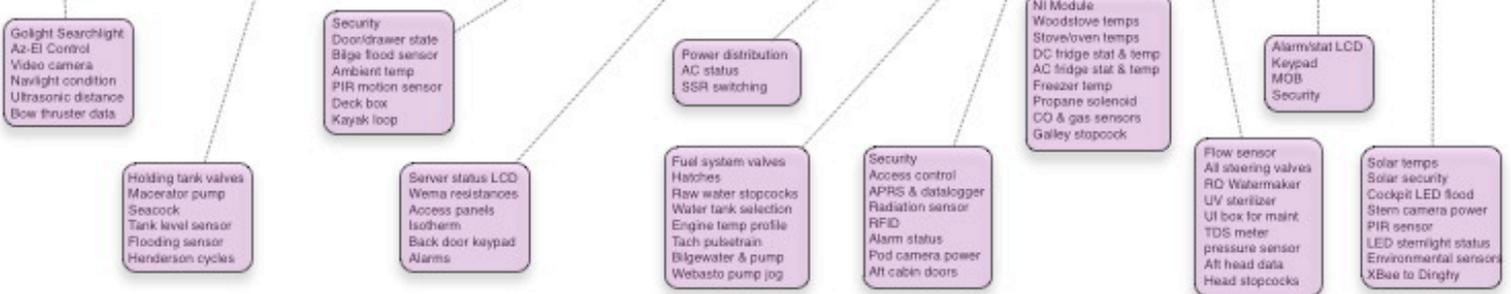
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-Steve

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Lots of changes in the air! The schedule slipped last week; not only did we lose a beloved cat (The Ghost of Harry Mitchell) but we also acted on an opportunity that simply could not be ignored... renting lab/office/retail space along with an apartment upstairs. The building is right at the head of the *Nomadness* dock, and the veranda looks over the boat. We had no choice, though now there is the small matter of shutting down my home base of the last 13 years.

Meanwhile, of course, the project continues. This issue gives a quick intro to the new development site, then introduces the Waterworks system that is about to be implemented. This equips the boat with a desalinator as well as a comprehensive carbon/UV filter, and provides tools to process all incoming water or "polish" water from one tank to the other. The design includes sensors for valve position, flow rate, pressure, and dissolved solids... leading to some intriguing benefits. The full plumbing diagram is included in this issue (with a link to a larger version).

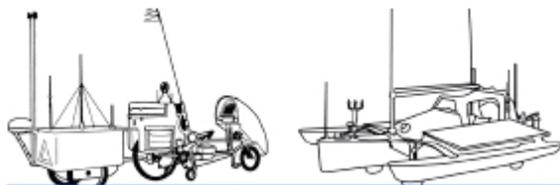
-- Steve



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The photo above is our dear departed Harry, best friend of Isabelle the boat cat.



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THE DEATH OF EXCUSES

All Together at Last...

Way back in Issue #1, I introduced the new facilities for the Nomadness project: mobile lab, small "retail office" space, and boat moorage all in the same small town. I still had the bulk of my tonnage in the 3000 square-foot Microship lab on Camano Island, and my partner has been living in the house there with occasional visits back and forth.

The *huge* news this week is that we have rented a building right at the head of the dock... an apartment with veranda upstairs and 2,000 square feet of workspace on the ground floor. With a few adjustments and some creative arranging, this is enough space to receive the complete contents of the old facilities, and the move has already begun!

In the photo at right (taken from my dinghy), the building is just behind the boom... and the late-night view from the open park at the edge of town is below. I'm keeping the mobile lab for dirty work, but will move everything else here including offices, nickel-generators, retail storefront, development lab, shipping, staging area, inventory of stuff that needs to go away, ham gear, music studio, boat provisioning, housing, and more. Crazy.

Meanwhile, I'm looking for a renter for the 4K square feet of shop and house in the woods of Camano Island. Need to build a boat or start a company? <grin> Photo album [here](#), as well as a [blog post](#) from a while back with some more details about the place.

The move will disrupt my already variable posting schedule, but your subscription is for a number of issues, not calendar year... and the new dev site is perfect so we had no choice. No more excuses for not making progress!



La Conner

This town is on the Swinomish Channel ([Google map link](#)), which runs between Skagit Bay and Padilla Bay. It is a protected passage to the islands from Puget Sound, though it's not without challenges including crazy currents that can be hard to predict, [siltng](#), and considerable traffic in nice weather. The [town itself](#) is very touristy and seasonal, with lots of galleries... my geekery is a bit of a non-sequitur here!

WATERWORKS

Plumbing Geekery

I didn't really expect *that* phrase to fall out of this project, but there it is.

At first, I was just looking at a few simple upgrades from the fresh-water system that came with the boat: toss the vintage watermaker and put in a new one, add some filtration, improve service access, and so on. Inevitably, I started contemplating interesting combinations of the available resources (like being able to filter water from one tank to the other), then sketched the associated data collection and discovered some serious added value from a network node. Hm... this actually looks fun.

Fresh water is a huge part of a voyaging boat, of course; it is a core component in the suite of self-sufficiency tools. *Nomadness* carries 90 gallons, split into two tanks, along with a water heater (Isotemp), pressure pump with accumulator, and distribution to the heads, galley, cockpit shower, inside shower stall, and laundry. A good start.

Now let's add a few features.

Filter

The gadget in the upper right is an integrated filter system that should make short work of unwelcome biology, chemicals, and particulate matter. Water enters the housing on the left, which prefilters it down to 5 micron chunky stuff, then passes through the one on the right for .5 micron carbon treatment. This takes care of nasties like giardia cysts, chlorine, and very fine sediment.

It then passes up and back to the left through the ultraviolet chamber, killing off bacteria, viruses, yeast, mold, and algae.

Watermaker

The gadget below is a svelte little reverse-osmosis desalinator, which pumps seawater at 800 PSI through a membrane to extract clean drinking water. This one is small, as such things go... drawing only 4 amps to produce 1.5 gallons per hour. When operating on a sunny day, that is about 10% of the solar power budget (the array is 420 watts).

If something catastrophic happens, the motor can easily be removed and replaced by a handle that lives in a clip next to the unit. A human pumping steadily can generate over a gallon per hour of lifesaving drinking water while bobbing around in the middle of the ocean.



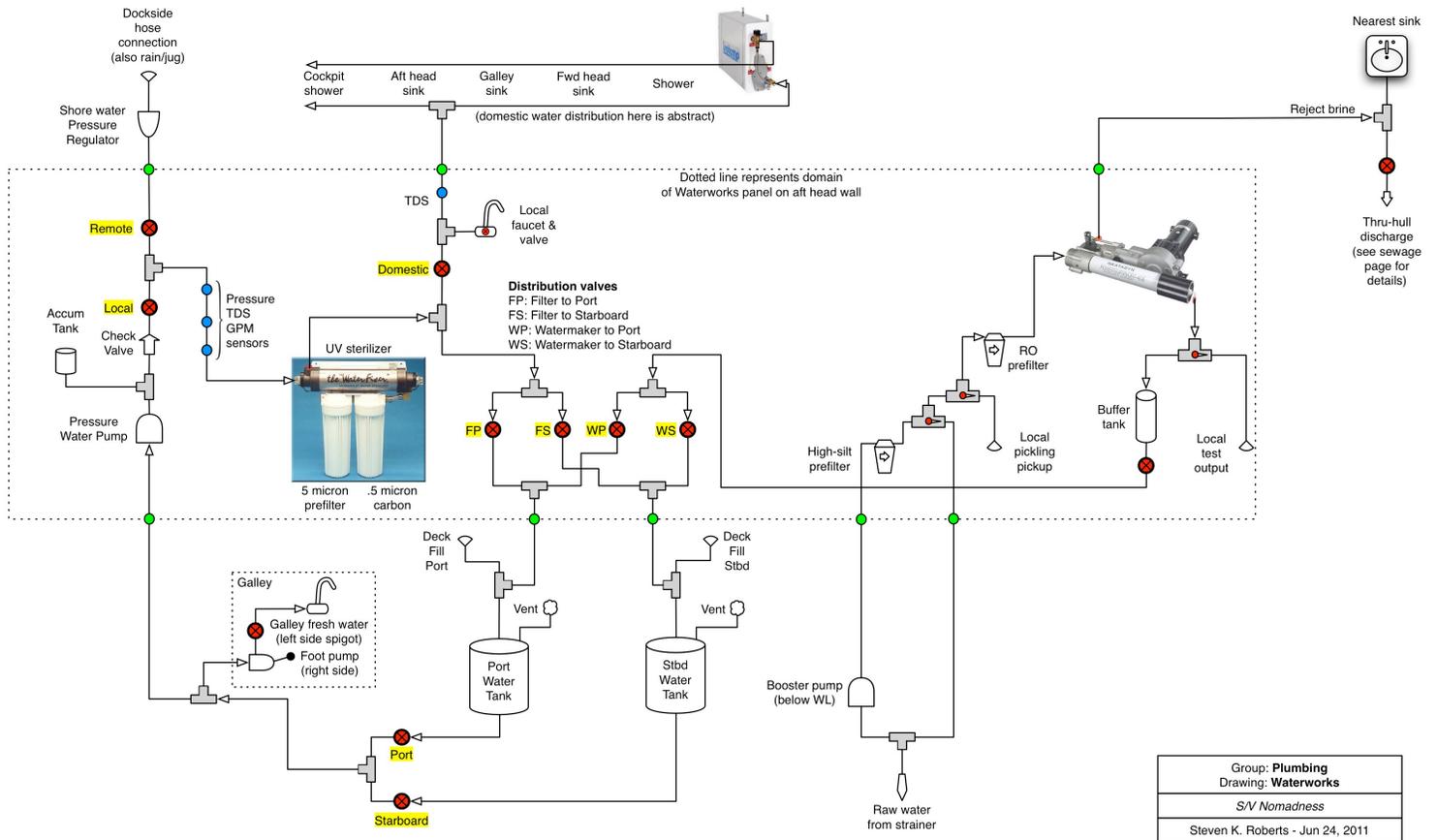
Two Key Waterworks Components

Above is the [Water Fixer 1000](#), with 5 micron prefilter, .5 micron carbon filter, and ultraviolet sterilizer. This is configured to allow processing of water as it is brought aboard, or "polishing" water from one tank to the other.

Below is the [Katadyn 40E](#) reverse-osmosis watermaker, which produces fresh water at sea. It is unique in the industry in that the motor can be removed and replaced by a manual handle if all ship's power has been knocked out.



WATERWORKS



Group: Plumbing
Drawing: Waterworks
S/V <i>Nomadness</i>
Steven K. Roberts - Jun 24, 2011

Configuration

As I started looking at the system integration, some interesting capabilities started to emerge. (The image above should theoretically handle PDF page resizing to be more readable, though you may prefer [this large image](#) at the nomadness.com site... especially if you're reading the hardcopy edition of this publication!)

The section within the dotted box is all being mounted together on the forward wall of the aft head compartment; those green balls are just there to highlight the "I/O" from this region and are not physical objects. The blue balls represent sensors that will be detailed in the associated node drawing, and the red balls are manual valves with magnetic position sensors.

The two 45-gallon tanks are at the bottom along with existing plumbing for deck fills and source

selection. The only current method for determining water level is a [Tank Tender](#) (a classic and reliable non-electronic device that displays the pressure required to manually pump air from the bottom of a selected tank, a direct function of the column height.) This information is not available to the server, so I've been wanting electronic monitors... but getting to the tanks to install them would be a nightmare as they were buried by a 2002 refit. A future serviceability issue, that.

At the top of the drawing is a simplified sketch of the distribution around the boat, and in the upper-left corner is a shore water connection. People argue endlessly about the advisability of this, since a leak aboard has been known to sink the occasional boat at the dock (presumably those with inadequate bilge pumps, no alarms, and no attempt to limit the flow rate). This

will have a shore water connection, with internal and external shut-off valves, a pressure/flow regulator, and a place on the "post-flight checklist."

Here's where it gets fun. I can choose between the internal pressure water system or the shore water supply (with a mechanical interlock, not shown), then pass that through the string of sensors and the filter before it is routed to domestic distribution... along with that little row of four valves.

These determine which tank gets the filtered water (which could have come from a tank)... or fresh water from the desalinator. It's really simple, but I've never seen a similar setup on another boat; tank water can be cleaned and returned to either tank, shore water can be properly processed before being stored, and sea water can be directed to a suitable destination after a small buffer tank for quality testing.

WATERWORKS DATA COLLECTION

The Node's Job

We could simply call this done (once it's actually built, of course!), but some additional capabilities become available with the addition of a local microcontroller.

If you've ever seen an industrial control environment, you might have noticed screens that show a live display of a process... graphic representations of valve positions, tank levels, temperatures, and so on. This may seem like overkill on a sailboat, but there are a number of areas, like this, where it is easy to imagine getting confused... once plumbed, things rarely look as clear as they do in the drawing. The photo on this page, in fact, includes that little cluster of four valves in the middle of the big drawing (just laid out on the workbench; this is not yet installed).

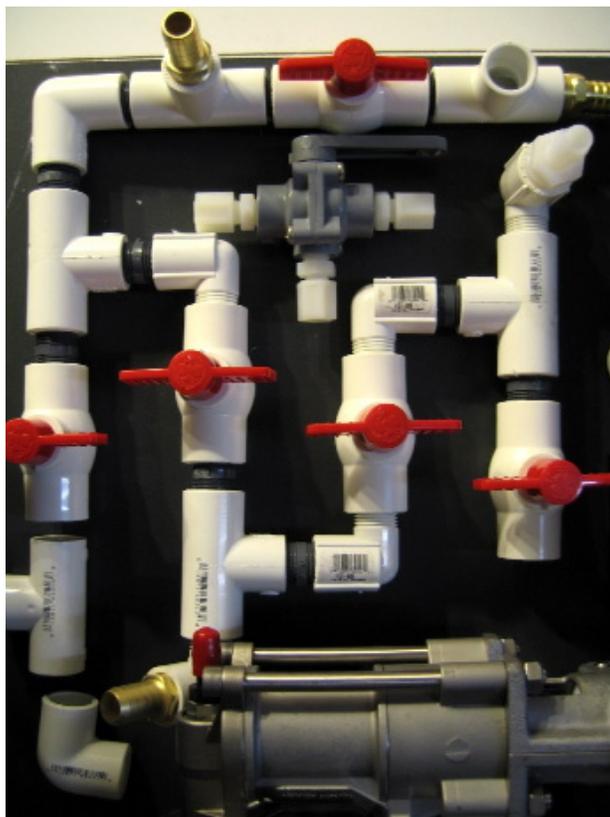
While I would be wary of automating this with solenoid valves (I really don't trust computers *that* much), it's not hard to pick off their position with an input bit and use that to change line colors on an associated image presented in a browser. Looking at the system schematic with inactive connections grayed out and others bright green would go a long way toward reminding a tired human about how the whole lash-up works.

That gets even better if we incorporate flow measurement. Using a [flow sensor](#) at the "choke point" to the left of the filter in the schematic, we suddenly have the tools to integrate water usage (or fill-up), with a local display showing tank level percentage both graphically and numerically. Also, since the system will know where all the flow is happening, it becomes easy to keep track of filter media life and pop up an alert if it's getting to be time to do some maintenance.

My first experiments with the valve position sensors simply used tiny neodymium disc magnets glued to the handle and a reed switch glued to the body. This worked fine on the bench with a wood mockup for code testing, but really gets messy on the PVC valves shown here (not only tricky adhesives, but long fragile glass reed switches that don't tuck nicely into place). A better solution is an integrated Hall-effect sensor such as the [US1881](#) (about a buck apiece) that can be encapsulated in a little blob of goo. I'll report after testing...

Timing

This whole system is happening in parallel with the new power distribution system, another in the daunting category of *infrastructure projects* that need to be done before attention can turn completely to more enchanting gizmology. Fortunately, there is nothing keeping us from making this part fun as well... with networked hooks for future data collection and system integration, and added capabilities that would be impossible with off-the-shelf marine chandlery hardware.



I'm not really sure about these valves yet; Pex and its variants are tempting but expensive. Also, all hoses from the rest of the boat are old-fashioned vinyl that likes barbed fittings.



Gems FT-330 turbine flow sensor, up to 4 gallons/minute.

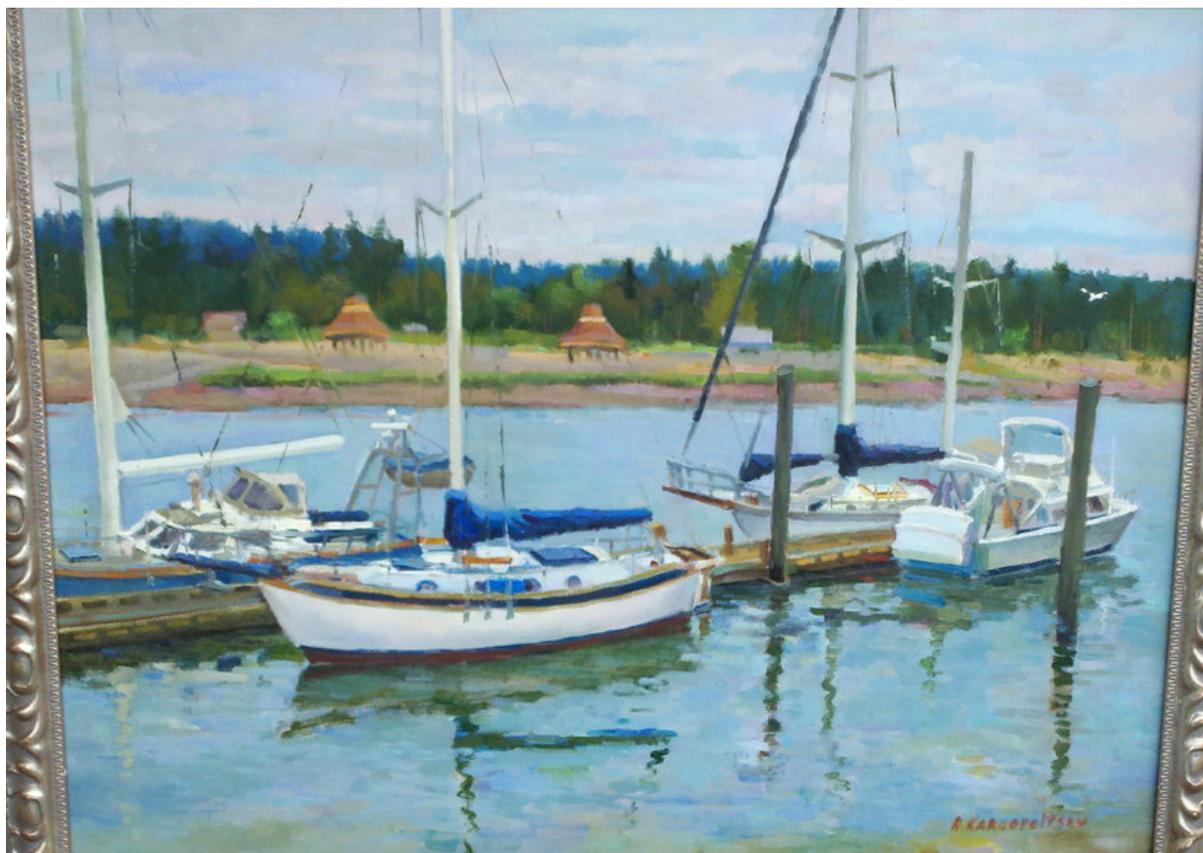
SCHEDULING BURPS

There will be a few short issues of this report, with somewhat asynchronous timing, until we get moved into our new facilities in La Conner. 4000 square feet is compressing into 3000, *Microship* is going in the water behind *Nomadness*, offices are moving, retail space being set up, and more. It's completely daunting... and 'tis the season for sailing so it's a little maddening as well! This will pay off in the long run, but is a massive undertaking for two overloaded humans.

Still, I'll be taking a couple of days a week to focus on design issues and chip away at the project lists, so there will be fresh content even during the move.

I'm also starting a letters column with the next issue, so if you have comments about anything in these first 9 issues, please feel free to drop me a line (wordy@microship.com) and I'll try to answer.

Painting below by [Aleks Kargopol'tsev](#), spotted unexpectedly today in La Conner... *Nomadness* is at left.

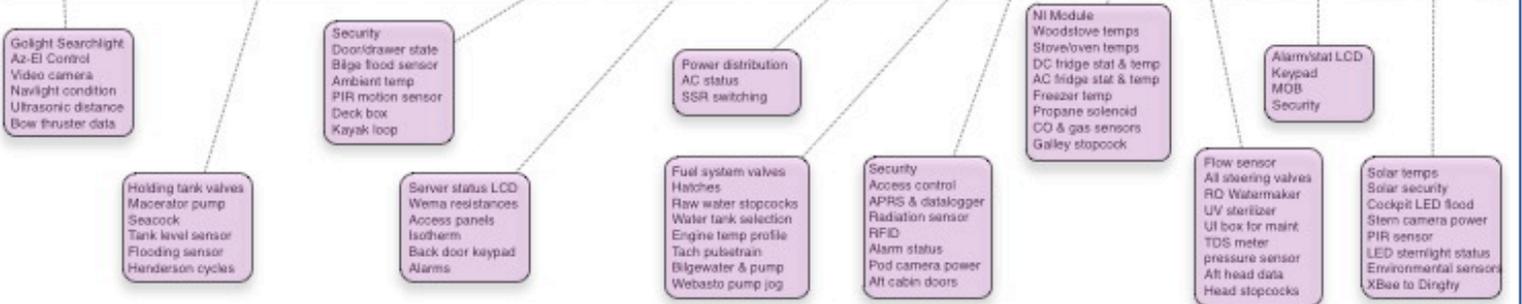
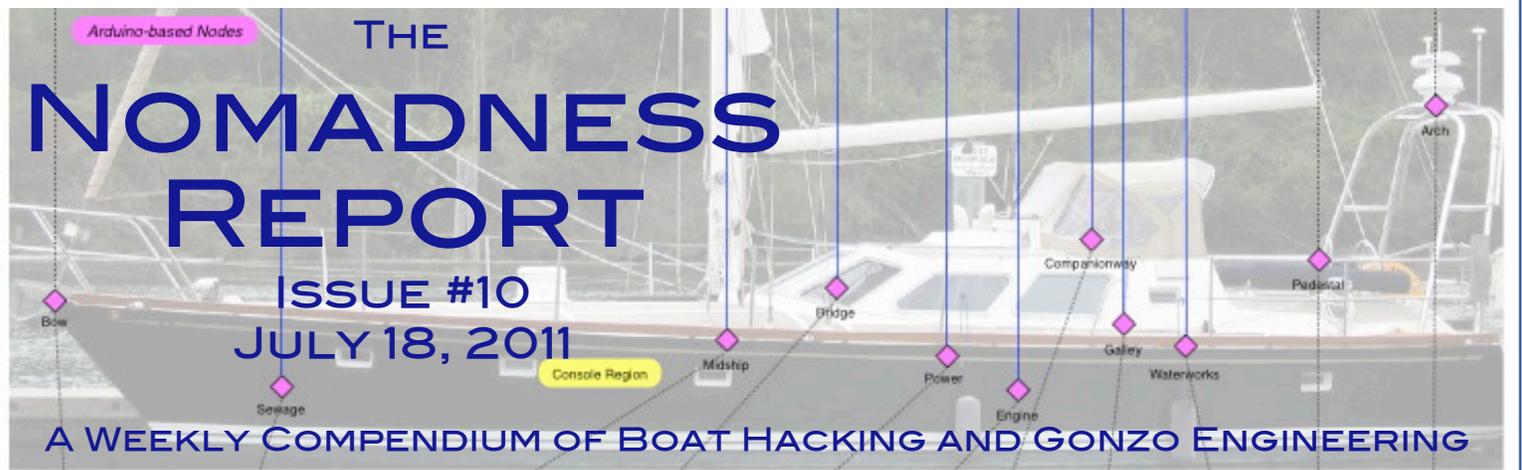


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Cheers, and thanks for subscribing!

nomadness



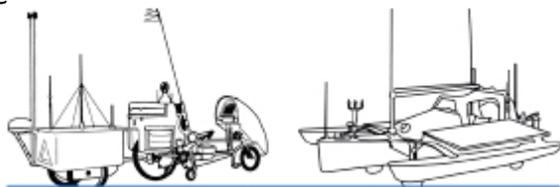
TRACKERS AND DATALOGGERS

Thanks for your patience with the reduced publishing schedule during this move to new development facilities! It's a monstrous project, but is going well... offices and living space are set up, shipping department running smoothly, and the storefront sparse but inviting (curtained off from the messy parts, anyway). The big truck with lab tonnage is next.

With these teasing snippets of summer, we're getting interesting nautical visitors cruising through Swinomish Channel... sparking little pangs of longing that are a useful reminder of what lies ahead (and why it's worth all this effort). While working on *Nomadness*, we'll take time for teasing excursions aboard kayaks, the sailing dinghy, [Microship](#) (which is moving here soon), and of course the big girl herself.

This issue gives an update on a decent project management program for the Android phone, then focuses on the tools I've been using to generate graphic tracks of voyages various. There are quite a number of ways to do this, yielding very different classes of results... we'll look at two orthogonal approaches that lend themselves well to on-board applications.

-- Steve



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The photo above is from a solo voyage aboard kayak Bubba, described in a [CQ VHF](#) article about harsh environment APRS tracking.

PROJECT MANAGEMENT UPDATE

Checkmark

A few issues back, I reported on an attempt to do graphic to-do lists in the outliner portion of OmniGraffle Pro. While I absolutely love this program for doing drawings (like the Waterworks diagram in Issue #9), I found that it was a bit too much overhead for what basically amounts to a sprawling, segmented, frequently updated outline.

Having recently moved a significant chunk of my life into an Android smart phone (the Droid X), I naturally wanted to find a way to manage the project there... using a gadget that's always in my pocket instead of a Mac parked at a desk. Over the past few months, I've experimented with a few to-do list programs, and generally found them frustrating... until this one.

Although it is new and still has a few minor usability glitches, [Checkmark](#) from Greenbeansoft is the first of the crop to make it past the learning-curve stage here and become a daily tool. Alas, there is no iOS version... but if you're an Android user I can recommend this.

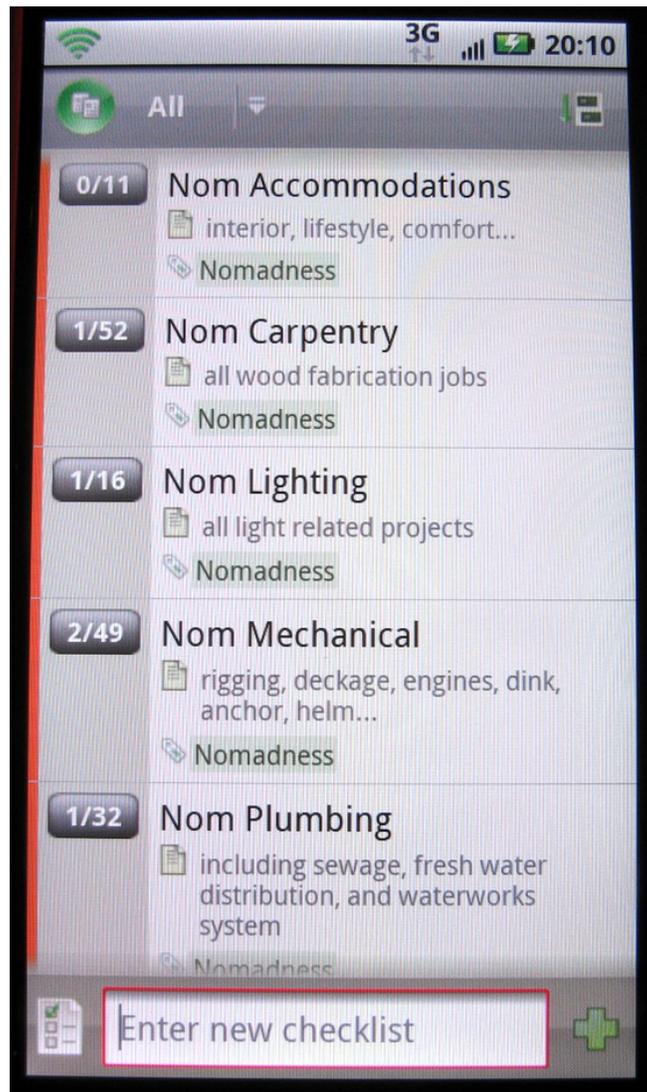
There are two metaphors in the program - tasks and checklists. Tasks are single actions with more variables available, and can be clustered into categories; when you check one off, it disappears and goes to a completed items collection. I use these for business to-do items and other stand-alone things that just need to get done and then disappear from my radar.

The screen image at the right shows the other metaphor, with some of the project checklists. The buttons with numbers on the left indicate how many items have been checked off relative to the total (I know, depressing), and I have given them all a title prefix of "Nom" so they will cluster together alphabetically. They are grouped by categories like basic tasks, but each checklist is a collection of items (which can be nested by creating additional lists).

One of their usability errors was calling these sub-checklists "categories," which is also what they call the broad high-level groupings (personal, business, etc). They also use different actions (short press vs long press) to edit tasks and items in a checklist, which is highly inconsistent given the nearly identical operation. These sorts of things annoy me, but the company was responsive to my comments and will hopefully fine tune the product over time.

That said, I'm very happy with it... adding items is easy enough that it actually happens on the fly (unlike my earlier graphic approach that felt more like preparing a presentation than dynamically tracking a complex project, or the excellent OmniFocus that did all this and more but was tied to a big computer). The program interoperates with Calendar apps, easily handles backups, and allows exporting checklists or sending them via email. This latter function can take the form of a Checkmark file (which I have not tried) or HTML; this is very convenient for publishing the current state of a project as I have done on the next page.

As I indicated above, the neat thing about Checkmark is that it's actually with me all the time. After a recent and



disruptive system crash, I've been shaken out of the habit of doing everything on the MacBook Pro... I've come to prefer keeping management tools and basic communications in my pocket instead of in a heavy backpack or parked on a desk. My slow transition to this has been a function of software quality and limited network choices in the old facilities on Camano Island, but now that a "phone" is actually a capable pocket computer and connectivity is ubiquitous, we seem to be moving forward with startling rapidity.

As to *Nomadness*, tools like this are a tease as much as a planning aid. We're in the middle of moving to the new facilities in La Conner, so tidy projects checklists serve to remind me of what I'd rather be doing instead of hauling boxes and setting up lab facilities!

Soon. Really.

EXPORTED PLUMBING TO-DO LIST

Title: Nom Plumbing

Note: including sewage, fresh water distribution, and waterworks system

- Waterworks**
 - capture design in Omnigraffle
 - choose plumbing standard for local interconnects
 - lay out wall hardware
 - mount valve matrix
 - mount flow sensor
 - install Katadyn desalinator
 - install UV filtration system
 - relocate pressure pump and related hardware
 - integrate into ship water system
 - add shore water
 - Note: flow limiter, shut off, and solenoid valve*
 - install and cable sensors
 - design Arduino waterworks node
 - interface sensors
 - write code and server tools
 - fab local interface panel
- Raw water**
 - add washdown pump after testing engine one
 - label ID'd hoses
- Sewage aft**
 - decide re compost toilet
 - remove Lectrasan and other junk
- Sewage forward**
 - improve leaky T12 fitting
 - re-do access hatch from First Mate Marine sloppy work
 - check Henderson valve integrity
 - add a Tank Saver
 - check tank depth for new Wema
- Water heater**
 - complete Isotemp mounting
 - design solar water heat augmentation
 - mount heat exchanger on dodger after stainless retrofit
 - add solar circulation pump, expansion tank, etc
- Miscellaneous**
 - check for intermittent whale foot pump leak
 - add shower sump check valve
 - trace old aft head sump drain and seal unless useful for waterworks leak management
 - solar array rain water catchment

GPS TRACKERS & DATALOGGERS

I am frequently asked about the tools I use to create the *Nomadness* track images in blog posts, and there are enough different ways to do this that the subject can be a little confusing.

The most accessible method these days, of course, is to just run an app on your iOS or Android phone... but this doesn't scale well for extended voyaging (eats batteries, exposes your communication lifeline to the elements, gets in the way of other uses, requires server support for graphics, etc). So let's not do that.

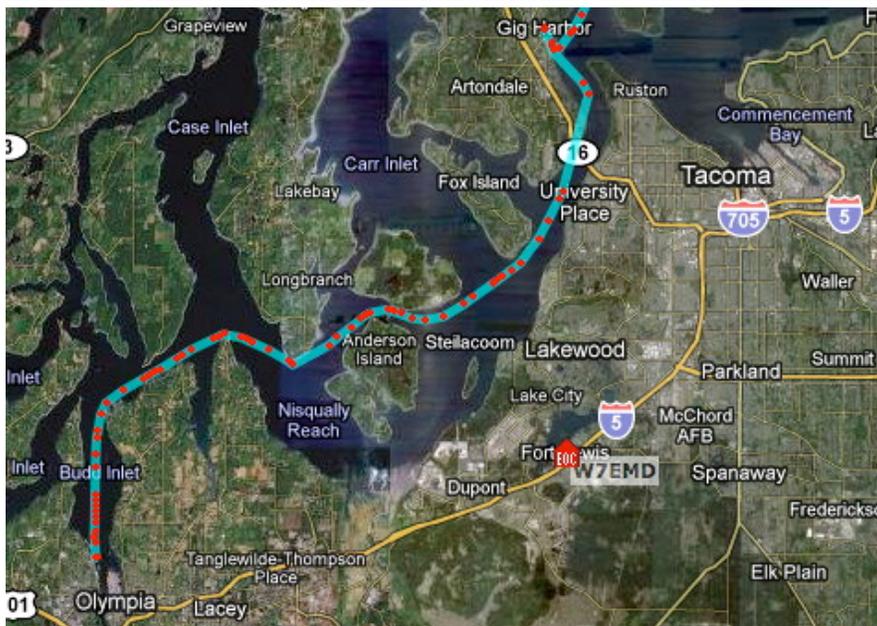
Another common method uses your nav software (whether on a computer, or baked in to a dedicated chartplotter) to save track logs. [MacENC](#) does this very neatly, exporting KML files that play nice on Google Earth; I have not tried it with appliance chartplotters.

In this article, however, I want to talk about two other methods... each very different from the above and each other. The first is a dedicated datalogger that stores a GPS position in an SD card at any specified interval (I do it every second), yielding a massive text file that can then be used to create overlays on Google Earth like the top image on the right. With such resolution, these allow you to zoom deep into an interesting detail like a sloppy docking maneuver or tricky series of tacks. I'll show a few examples, including a couple of rather embarrassing ones.

The other method transmits location "packets" in real time via amateur radio, using a protocol called APRS. If your adventure is highly public, or you have friends and family watching over your shoulder, this might be preferable. It lacks the close-up resolution of the datalogger, but appears live on various websites around the Net... making it easy to capture an image like the one at lower right (this is from [aprs.fi](#) using Google maps, though [findu.com](#) is the original; both links go directly to my own position). The red dots are actual position reports, and materialize on the map as they are received. This is most entertaining while sailing, with friends commenting on live position and Facebook updates.

You can do this with SPOT, but updates are infrequent. You can also build a track with AIS over marine VHF, though I'm not sure about extracting detailed logs from the client software (I haven't tried). AIS channels can get very congested in busy shipping areas; I'm a believer in the technology for safety reasons, but I would not want to depend on it for the kinds of applications discussed here.

Let's start with the dataloggers...



GPS DATALOGGERS

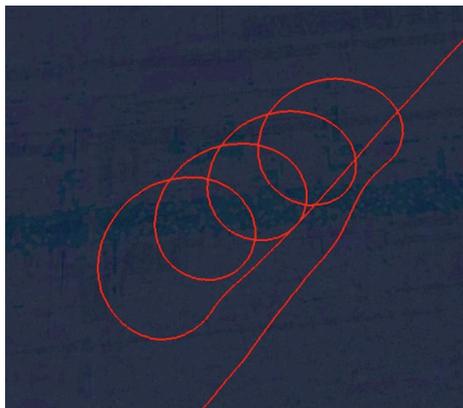
Back in 2003, as I was making local kayaking jaunts in [Bubba](#), I was fond of manually creating “maplets” that ended up [collected](#) on my website. This was a bit labor-intensive, but I came to appreciate the value of archiving one’s adventures in graphic form.

Soon, folks were starting to make little circuit boards with an embedded GPS, an SD card socket, and a microprocessor that records the location at specified intervals. I bought one of these from the good folks at [Sparkfun](#), and packaged it in a carved foam insert tucked into a SealLine Electronic Case:



The antenna is lost in the glare; below that is the board, which carries a Lassen iQ GPS, an LPC2138 ARM processor, and a socket on the back for the SD card. The software strips the NMEA sentences to just the basics, and stuffs them into the card.

The resulting file is vanilla, and doesn’t work on Google Earth. In the Olden Days, I had to manually paste the data points into an XML-like file with appropriate headers and footers, but now there is an easier way... just hand it to the online [GPS Visualizer](#) tool. Instant track overlay! Here I am, calibrating my Rate Gyro compass:



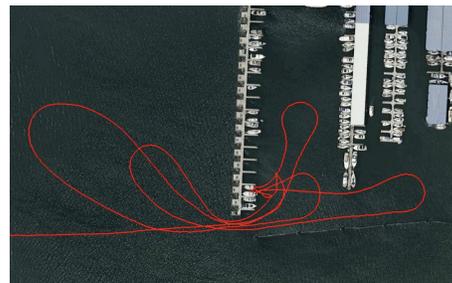
(This is a fun one. The task was to do three full 360° loops while the Maretron unit was in learn mode. What I didn’t know is that there was current running in Drayton Passage.)

I still use this little datalogger, though of course there are newer models available. One called the [Geochron Blue](#) (also from Sparkfun) has an appealing feature set including internal LiPoly battery, Bluetooth connectivity to a nearby computer, and a variety of useful operating modes. On a hunch that others might enjoy this, I bundled it with a sealed Pelican case, SD card, and power cable... and now [sell it as a kit](#).

With a 1 GB card, it’s good for about 9.6 months of continuous logging at one data point per second, which should be plenty since the normal mode is to turn it on only when underway (creating a new file in the process). The unit can be left sealed in some sky-visible spot, permanently powered via a switch below, wirelessly feeding track files to your laptop on request. The box is 4x6 inches:



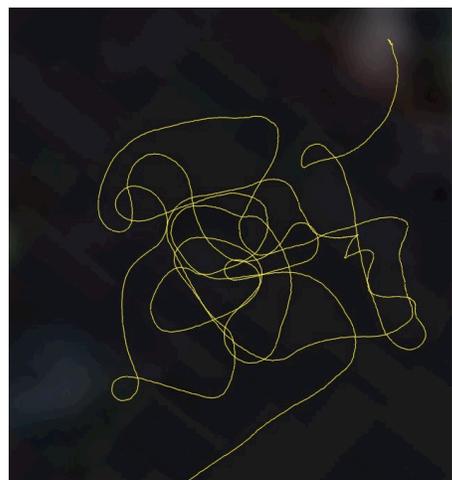
I mentioned having a couple of embarrassing files to share. The full 2008 inaugural cruise of Nomadness is [visible in this image](#) (on my server, since you’ll want to view it big). But if you were to zoom into the original with Google Earth, you’d find my first attempt to dock 18 tons of angry steel in a stiff sidewind, making the slip on F Dock at Oak Harbor Marina look very skinny indeed:



When I look at it, I wince at the memory of getting blown off on three successive attempts... finally taking a big run outside and a long straight approach.

The other [has its own story](#) along with a deceptively simple track image. <sigh> A close call, that one.

This whole approach to recording your travels is a bit geeky compared to some of the alternatives mentioned on the previous page, but the ability to drill down into the details is very useful... and at times, funny. I’ll leave the subject with this image of my “holding pattern” while awaiting moorage in Pender Harbour...



APRS TRACKERS

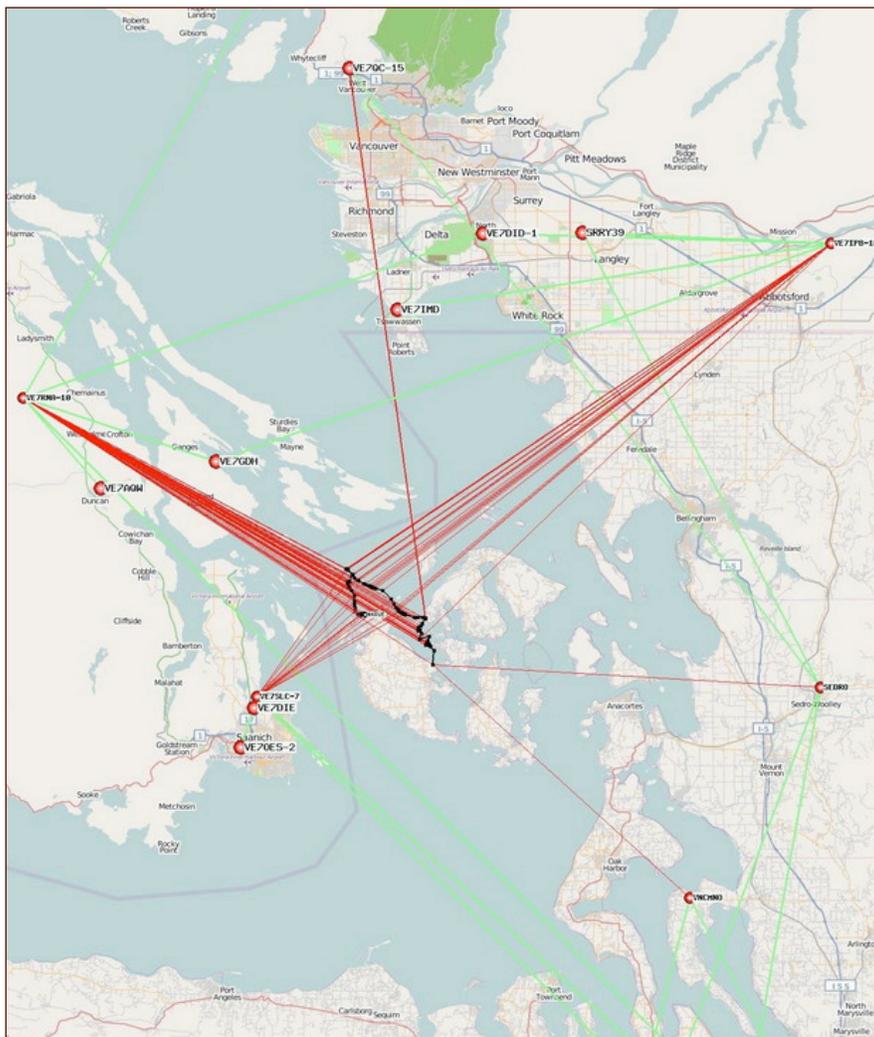
Live Location Updates

Dataloggers may offer high-resolution track information, but I've had much more fun with APRS... an amateur radio toolset that lets me transmit a position packet (sometimes called a "posit") every minute or so, which is appended to a visible track overlaid on Google maps.

The image at the right (by Lynn Deffenbaugh, KJ4ERJ) should help visualize how this works. The track itself is that black squiggle in the northwest quadrant of the San Juan archipelago. To most folks viewing the boat's progress, only this would be visible (with a zoomable backdrop of satellite imagery).

The straight red lines show the paths that my transmitted signals took. Every 90 seconds, my tracker beamed the current GPS location, but many times the signal fell on deaf ears since it's open-loop and not based on establishing a connection. Often enough, however, it would get picked up by a fellow ham's APRS station and forwarded to others... or directly to an "I-Gate" or Internet Gateway. (The image shows the first hop in red, with additional traffic paths in green.) Even though my tracker was only running .5 watt transmit power to a little quarter-wave whip antenna on the deck, it covered considerable ground to high-profile stations in Canada.

It's important to note that this does not require an Internet connection... at least until the I-Gate slurps all the radio traffic and forwards it to distant servers. A large part of the APRS community runs software that talks



directly to the radio and displays positions on locally generated maps.

To the rest of the world (like your friends and family, who don't have to be ham radio operators to enjoy this technology), the view looks like the image at left... which includes the segment we saw earlier along with the next couple of days as *Nomadness* made the trek into Canada and on to the delightful Ganges Harbour on Salt Spring Island.

In addition to making your desk-bound friends envious, this adds an entertaining cultural layer to an on-water adventure. Most APRS users are in cars, so a meandering track through interesting waters tends to capture a lot of eyeballs. I've had folks email me to say they have a window up on their desktop at work, displaying my slow progress through beautiful island groups overlaid on Google satellite imagery. I've also had people waiting for me at a harbor (or even waving from a beach), just popping by to say hello after watching the approach. I suppose one might fret about the security implications, but I've never had a problem... though if it were required by law I would be fighting it with vigor!

Let's take a look at the hardware needed to accomplish this.

APRS TRACKER HARDWARE

There are a couple of ways to do this. The traditional approach uses a fully capable ham radio along with a terminal node controller (TNC) with attached GPS. The rig listens on the APRS frequency (typically 144.39 MHz) and at a clear moment transmits a packet with embedded location data and optional telemetry. This is fairly hardware-intensive, as you can see in the photo below; this rig is currently in my truck, and accompanied me on the *Bubba* kayak [described in detail here](#).

The bottom unit is a 25-watt Yaesu 290 multimode 2-meter transceiver, with a Kantronics KPC 3+ stacked on top and cabled to the mic, speaker, and PTT ports of the radio. A Garmin GPS-35 is velcro'd to that, along with a USB-serial interface and power switch. This is a very effective tracker that has covered a lot of miles with me, but it's too much to tuck into a nacelle and think of as a black box. On the other hand, it offers the flexibility of

normal packet operation; all I have to do is plug in a laptop and I can connect to the somewhat dormant (but cool) radio-based network, useful as a backup for data comms in the field as well as an interesting segment of ham radio culture.



The tracker on *Nomadness* takes a much different approach. Built by [RPC Electronics](#) and based on the [Open Tracker](#) 1+ platform, this little 2x3-inch box connects to 12-volt power as well as VHF and GPS antennas... and then, based on initial setup via an external PC, transmits position reports at the specified interval. Like other basic trackers (including OpenTracker) it does not by default listen on the channel first (a topic of some argument in the APRS community, though that function is possible with an added receiver).

The beauty of this is that it's small and low power (only 40 mA standby, and 350 mA during brief transmit bursts with 5 watts into the antenna). Standard frequency is 144.39 MHz, but they can work anywhere in the 2-meter band.

These run about \$250, and I'm working with Jason at RPC on an OEM deal that will allow me to sell a version packaged in a sealed Pelican case with on-board antennas, much like the data logger on page 5. Please let me know if you want one! When I make my own to replace my current low-power model, I'll post photos here.

Now, back to moving! I'm looking forward to getting settled and into full-time nautical geekery.



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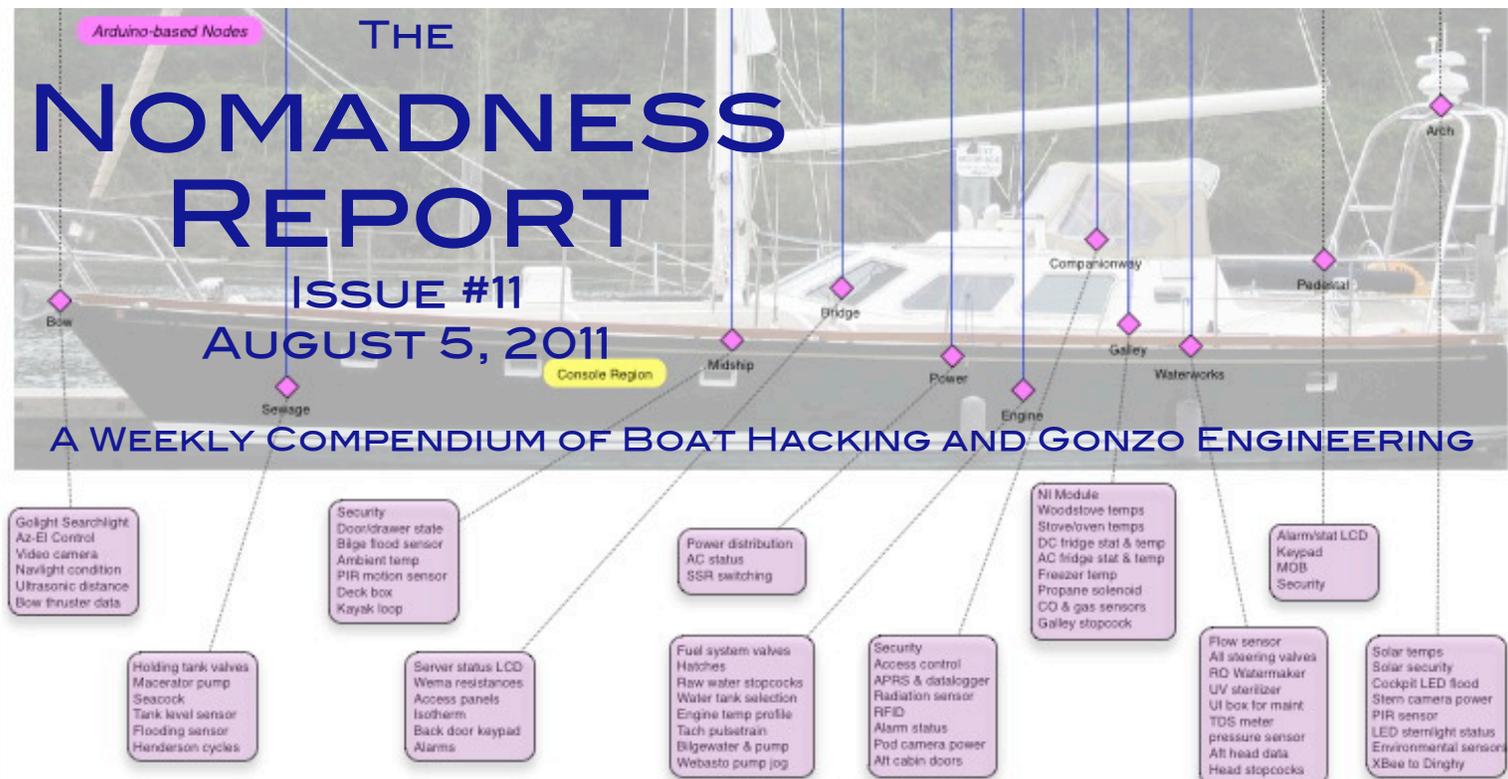
-Steve

nomadness

THE NOMADNESS REPORT

ISSUE #11
AUGUST 5, 2011

A WEEKLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



KEEPING AN EYE ON THINGS

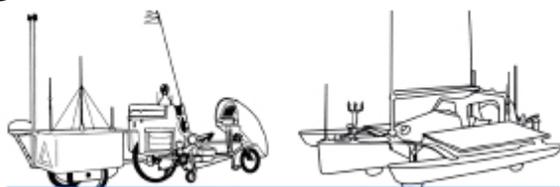
Thanks for your patience through this tedious time of setting up new facilities... I could keep up a weekly schedule, I suppose, but the content would degenerate to discussions of furniture and shelf assembly. I'll spare you that, and stick with the central theme of nautical geekery even if weekly deadlines are missed during interludes of logistics.

I have a fun topic for this issue, though: the boat's webcam. This got a lot of traffic last week, peering across the channel toward the Swinomish Reservation during the arrival of over 100 tribal canoes from all over the Salish Sea. That event is over now, and the camera is now looking south on the Swinomish Channel, updating every 10 seconds.

There are a number of issues with setting up such things, especially with the intermittently thin network pipe of a boat instead of a home router providing a solid upstream connection. The article is about all that, though light on detail since implementations vary widely.

In addition, I offer a few brief suggestions for survival in times of crazy economic upheaval, then wrap up with a quick look at our new facilities.

-- Steve



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The photo above was from the August 1995 issue of Kijk (Holland). Full photo [here](#).

HISTORY: TURRET & CROSSBAR

Looking Around

Back in the Microship epoch (mid-'90s), I looked at the cost of cameras and decided that the best approach would be to install one very good one in a sealed turret, then drive it to any desired angle under software control. By the time this rather ambitious project was complete, it had a graphic front end on a wireless Newton, could scan between any pair of angles at any specified speed, protected its delicate CCD imager with a servo-controlled retractable "lens cap," allowed manual override of zoom and focus, and carried an additional B&W low light camera as well as a laser (just for fun). Housed in a pressurized acrylic enclosure, this had a dedicated 68HC11 controller running FORTH, appearing as one of the nodes on my multidrop network.

Of course, cameras are so cheap now that it's a lot easier to just scatter them around and choose among them. I might still use this machine, though... as a steerable WiFi beam antenna to keep a shoreside access point in sight while swinging at anchor.

The [full design of the video turret](#) is on my website.

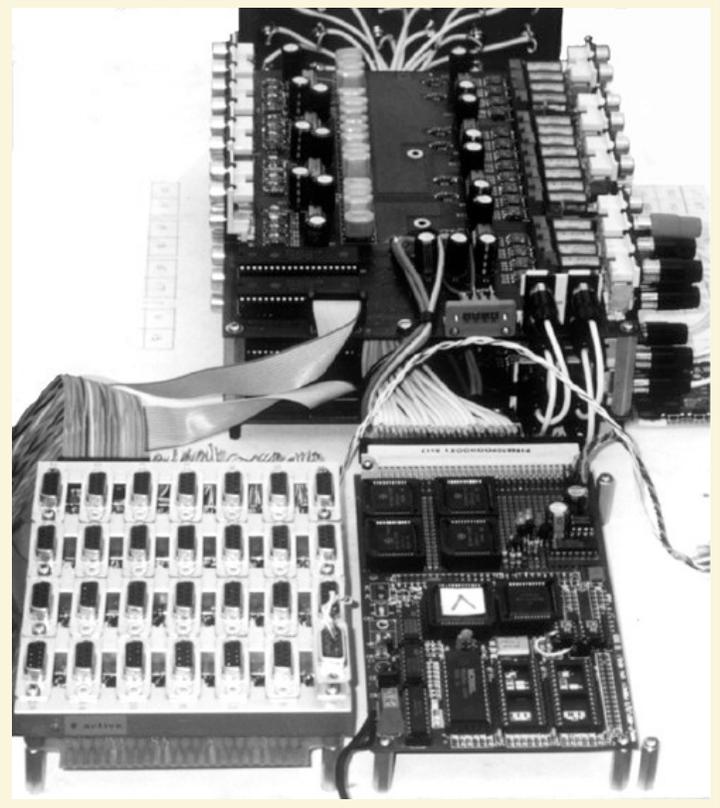


Grand Central Station

A related node in the Microship system has a distant descendant that will appear in Nomadness... a crossbar matrix that can connect anything to anything under software control.

There were three of them on the previous system: Auxbar, Sexbar, and Vixbar (audio, serial, and video). Each used Mitel crosspoint switching chips, wrapped in circuitry optimized for the signal type. I could connect any of 32 audio inputs to 32 outputs, 16 video in to 8 video out, and make any random link among 32 serial devices... all under local FORTH control with three nodes on the same network as the turret. A command such TURRET VCR VCONNECT would simply make the specified connection, frame-synchronized to prevent switching glitches. The crossbars drew very little power, which was a key design issue.

All this worked beautifully (here's more about [Auxbar](#) and [Sexbar](#)), though of course are a far cry from modern networking standards. Still, the near-universal flexibility allowed me to postpone a lot of design decisions, since writing interconnect-intensive applications around this tool was very simple.



NOMADNESS WEBCAM



The general utility webcam aboard *Nomadness* is an [Axis 210](#), though as you can see from the link it is no longer a current product. The key characteristic of this class of cameras compared to the familiar webcams people use for video chat is that it does not require a computer... it has an internal Linux machine that is a web server, provides a browser-based administration interface, handles motion detection for security, transmits captured stills, and a lot more.

For a marine application, that's ideal; I don't want to depend on a computer for something that has to work all the time. [Mine is always on](#), and depending when you look, you might watch me work, see an empty boat, or look out the window down the Swinomish Channel, updating every 10 seconds. Here at the development site, it reaches the Net via a router (Cradlepoint MBR1200) and an Ethernet-WiFi bridge (Pepwave Surf Mini) talking to the lab's access point at the head of the dock. When underway in coastal waters, however, I use Sprint EVDO for about \$60/month.

It's important to note that when visitors look at the camera page (which got very busy during the recent [Paddle to Swinomish](#) event with over 100 tribal canoes),

they are not actually accessing the camera's internal web server (though I could certainly set it up this way). Since I have to stay conscious of bandwidth, I instead set up an "event" in the camera that executes every 10 seconds, grabbing an image and sending it via FTP to my web server thousands of miles away... replacing the previous static image



of the same name. The page there carries a bit of Javascript that forces a browser reload every 10 seconds, completing the illusion.

(This is actually not very clever, as it does not deal with the event of catching an image partway through being updated... resulting in the occasional incomplete frame. I suppose I should create a temporary file and do it right.)

The photo at the top of this page shows the camera peering through my marine binoculars. This works surprisingly well, as the vision point is on a plane similar to that of the eye and thus within objective focus range of the binocs. I keep the camera on a little tripod, with long Ethernet and power cables to allow relocation around the boat; when underway, it's instead mounted to a fixture screwed to a bulkhead.

I've been generally happy with this device, though administration can sometimes be fiddly (especially remote, port-forwarded through the router). I'm looking now at a 4-port camera server that does essentially the same thing, but accepts external analog video inputs... this will be more flexible when it comes to scattering waterproof cameras around the boat. For stand-alone IP network cameras, I'll start playing with other vendors' offerings since these are so expensive (\$350-400 for this model). The cheaper ones never seem to get as many good reviews, however, so I'll proceed with caution.

Let's take a look at setting this up for the basic webcam function as described above - using FTP to transmit still images at a preset interval.

WEBCAM CONFIGURATION

AXIS 210 Network Camera Live View | Setup | Help

Image Settings

Image Appearance

Resolution: 640x480 pixels

Compression: 20 [0..100]

Rotate image: 0 degrees

White balance: Automatic

Text Overlay Settings

Include date Include time

Include text: Live from S/V Nomadness

Text color: white Text background color: black

Place text/date/time at: top of image

Video Stream

Maximum video stream time:

Unlimited

Limited to 5 [1..] minutes per session

Maximum frame rate:

Unlimited

Limited to [] [1..30] fps per viewer

Test

Test settings (using Motion JPEG) before saving.

Basic Cam Setup

The admin interface is just an address on your LAN, with a non-standard port number (not 80) and a password. Once there, the camera shows a live view in full motion, along with a link to Setup tools. On the left, you can see one of the pages, with some of the menus visible.

These are quite comprehensive, and include network config, image fine-tuning, video settings, motion detection, and so on. This is the screen for controlling the image, just to give you an idea of the user interface. (If you want to read all about it in detail, their PDF manual is [over here](#).)

For brevity, I don't show the network screen - that's where you decide whether you want DHCP or a Static IP address. The former is fragile after crashes if you use a port-forwarding table to allow external administration via your router. That drove me nuts for a while. (The camera does support NAT.)

It also lets you configure an SMTP (mail) server, which is handy if you want to receive notifications of events like motion detection or a change of the input port bit as shown in the box at right. My camera emails me and sends a text message if there is a security violation... and this task runs independently of the webcam (though of course that's not active when it is staring out the window, or I'd be notified of every passing boat on the channel!).

The key component in all these actions is the "event" system, consisting of Servers and Types. The former are the building blocks for connections, such as an FTP server that links the camera to a distant directory on a web host. The latter describe how and when the camera performs actions... at an interval or scheduled time, when motion is detected in a specified part of the frame, a bit is toggled, or in response to a button in the web interface. For security applications, it can send the contents of a pre-trigger buffer, allowing you to see what occurred up to the time the event was detected.

Our webcam app is relatively easy. All we need to do is choose an interval, configure both local and server machines to play nice with the file transfer process, and tell it whether we want it to happen all the time or on a schedule. The screen on the next page shows the whole setup...

Input and Output Bits

One of the most useful features of this camera is a pair of I/O bits. The input can see a security loop (PIR motion sensor and perimeter switches on the hatches), triggering video capture and transmission if there is an intruder. The output can be used to turn on the lights, sound an alarm, or otherwise reach out with one bit of control in response to events (or commands via the web interface).

I am fond of stand-alone devices like this that provide auxiliary functions independent of huge, failure-prone, complex systems.

I/O Ports

Port	Name	Normal state is...*	Current State
Input 1	Input 1	Open circuit	Open circuit
Output 1	Output 1	Open circuit	Open circuit

*If the normal state equals the current state, then the port is inactive (see help for more information).

WEBCAM CONFIGURATION

Scheduled Event Type Setup ?

General

Name:

Priority:

Activation Time

Always

Recurrence pattern Sun Mon Tue Wed Thu Fri Sat

Start time: Duration: (max 168:00 hours)

Never (event type disabled)

When Activated...

Upload Images

Select upload type:

Upload to FTP server

Primary Secondary

Upload for:

Upload as long the event is active

Desired image frequency:

Maximum possible

frame(s) per

*Base file name:

*[See help for more information.](#)

Add date/time suffix

Add sequence number suffix (no maximum value)

Add sequence number suffix up to and then start over

Overwrite/Use own file format. [See help for more information.](#)

Use event-specific image settings.

Activate output port

Send email notification

Send HTTP notification to

Send TCP notification

THE SERVER SIDE

The FTP Dance

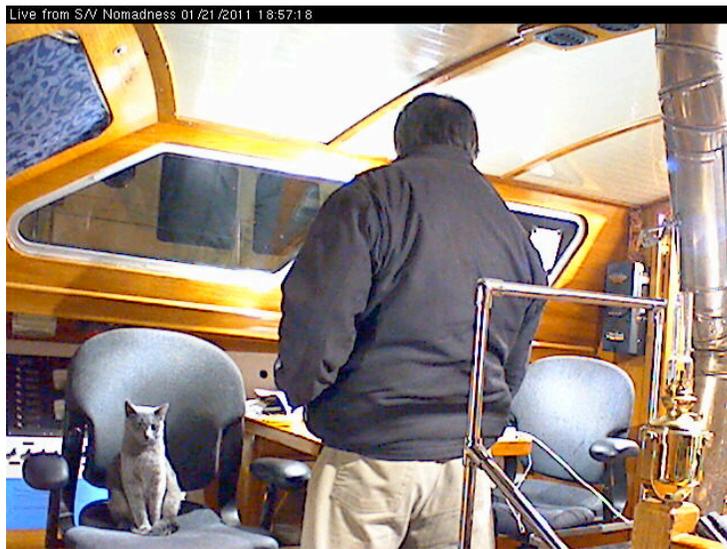
Now that we have convinced the camera to send 6 images a minute to a folder buried in the sprawling microship.com filesystem, we need to create some HTML that can display it in a browser. When you go to the [webcam page](#), you are opening a primitive file (nothing fancy) that includes this bit of script snarfed from the Vapours of the Net:

```
<div style="text-align: center;">
<script language="javascript">
var refreshrate=10; //SECONDS BETWEEN REFRESH
var image="nomview.jpg"; //IMAGE NAME
var imgheight=480; //IMAGE HEIGHT
var imgwidth=640; //IMAGE WIDTH
function refresh(){
    document.images["pic"].src=image+"?" +new Date();
    setTimeout('refresh()', refreshrate*1000);}
document.write('<IMG SRC="'+image+'" ALT="Alternate
Text" NAME="pic" ID="pic" WIDTH="'+imgwidth+'"
HEIGHT="'+imgheight+'" STYLE="border: 1px solid
Black;">');
if(document.images)window.onload=refresh;
</script></div>
```

That nomview.jpg is the image sent by the camera, and every 10 seconds it is simply re-transmitted by this script to your browser window.

The only setup via the Cpanel back-end on my server was to create a dedicated one-folder FTP account for the camera, reducing the chance of disaster if the password is intercepted... FTP is not secure, and I wanted to limit the scope of damage to a single directory. It doesn't know about SFTP.

At right are a couple of captured images from evenings working aboard, aided by Isabelle the cat.



Here's one more webcam pic, this time on a brutally hot night in a boatyard. I find myself forgetting the unblinking eyeball, but some caution is required!

Technomadic Tools & Uncertain Times

I stumbled across one of my old rants from a previous market crash, and these words seems apropos in the light of recent economic turbulence:

This is a time to learn skills, build off-grid backup power systems, create non-economic informal barter networks for tools and resources, plant low-maintenance gardens, get to know your neighbors better, implement alternative communication modalities, strengthen your off-site data backup procedures, lay in a deep inventory of foods that store well, learn to cook, buy a water filter and basic camping gear that is kept ready to go, eliminate debt, eschew consumerism, and convert your excess tonnage to cash (and thus into useful tools). Shed the things that would tie you down if for some reason you really wanted to relocate in a hurry. Make sure you and your family are on the same page about all this. Rekindle your network of distant friends (what I've always called the "hospitality database"). Deploy nickel generators to decrease your dependence on a single client or employer, and refresh your knowledge in areas that might serve you well during times of unrest or feed you as you pass through unfamiliar places.

DEVELOPMENT FACILITY NEWS

Finally, since the publication schedule has been impacted by this epic move from the old Microship Lab on Camano Island to new facilities in La Conner, I should give you an update in that department.

One of these days I'll do a layout drawing, but for now I'll just outline the spaces. We're pretty well set up in the building shown in Issue #9, with an apartment upstairs and all the geeky stuff on the ground floor (about 2,000 square feet). The mobile lab, parked just down the street, is becoming the place for "messy work," with the new facilities devoted to staging, electronics, office, publishing, and business.

We have segmented the central open space with internal curtains (surplus marine upholstery fabric), yielding five functional "rooms" in addition to three smaller adjoining ones. Here are the eight spaces in approximate sequence upon entry from the channel side (as seen in the photo below, taken from our verandah, with *Nomadness* on the far side of the dock):

- * Kayak port (about 120 sqft), with my Hobie i12s, Kirsten's Necky Manitou Sport, and related gear.
- * Inventory room (about 120 sqft) with shelves for boat-related parts, items awaiting installation, and other goodies.
- * Electronics lab (about 225 sqft) including a 4x8 work table that approximates the target console environment aboard the boat and an L-shaped desk for an interim ham shack. Everything will be built here, then moved aboard.

- * My office enclave (about 135 sqft) with U-shaped desk, computers, files, smaller work desk, & piano studio.
- * Retail space (about 160 sqft) with wrap-around glass windows and external access. There are display cases for Arduino and other gizmology, my publications, nautical antiques, and random gewgaws unrelated to anything.
- * Kirsten's office and [Expedition Medical Chest](#) inventory/staging area (about 130 sqft), including shelving and kit assembly table, document preparation area, and Sailrite sewing station.
- * Zone of Random Tonnage (about 300 sqft) for all the non-current clutter imported from the old place... stuff destined for eBay or other avenues of elimination. More in this category is in the attic off the apartment.
- * Shipping Department (about 160 sqft) with office supplies, scales, packing materials, and photo tent.

In addition, there's traffic space meandering through the middle of all that, giving it an open and productive feel. I'll include photos in a future issue (when it's not such a confusing work-in-progress mess!).

It's feeling good, though, with a deliberate sense of assembling workspace rather than the familiar scenario of elbowing aside the remnants of ancient projects to carve out a spot for the latest. I think this is going to work well, and I'm about to stop fiddling with facilities and get back to proper nautical geekery. Soon!

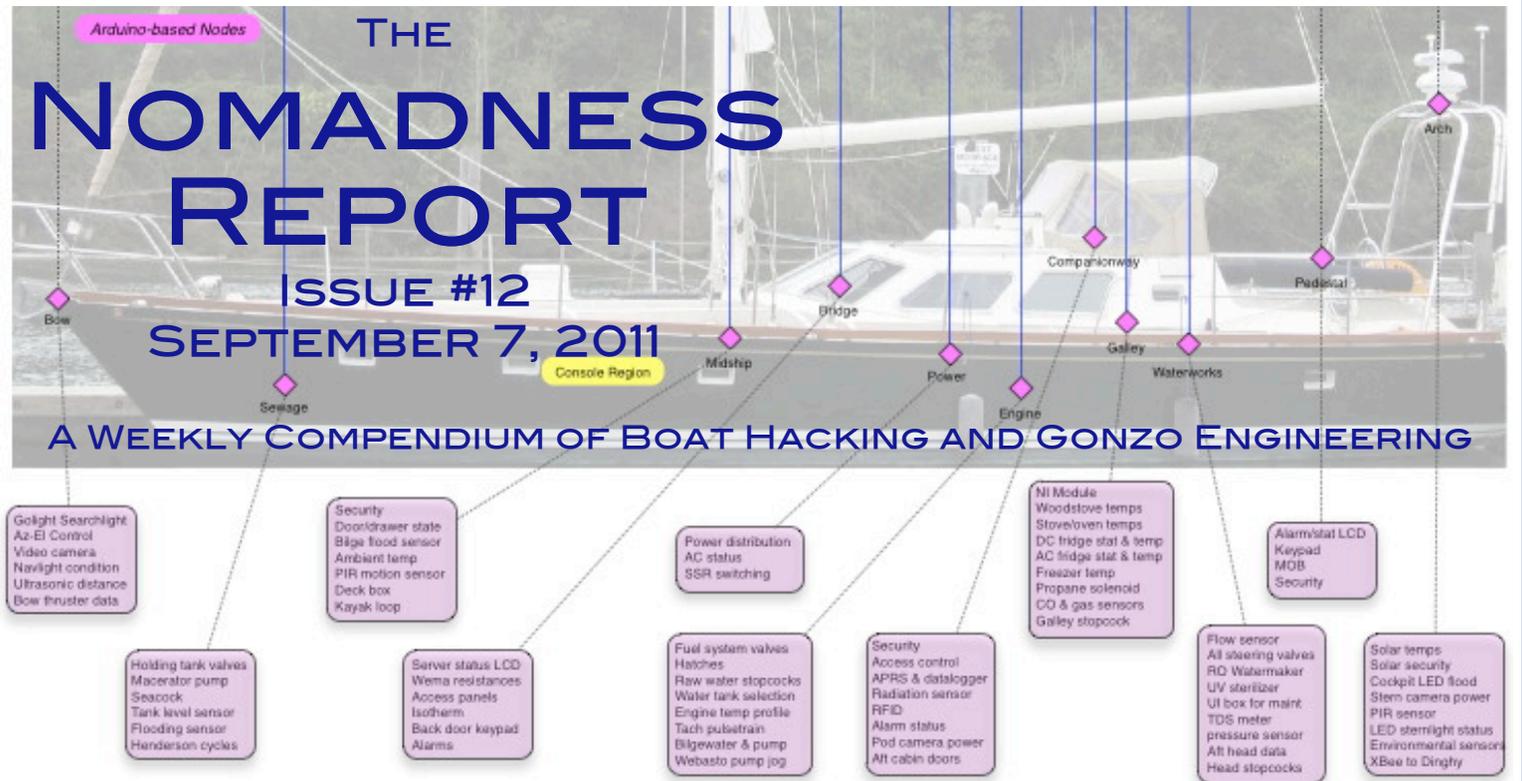


nomadness

THE NOMADNESS REPORT

ISSUE #12
SEPTEMBER 7, 2011

A WEEKLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



PROJECT RESOURCES

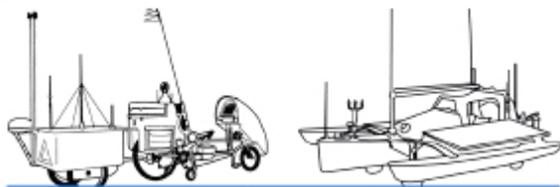
Yikes, moving has taken longer than expected (and it is not over)... but the new *Nomadness* lab in La Conner is now a working home base, and my old facilities on Camano Island may have a new owner soon. There's plenty of tonnage yet to haul, but doing it in stages has had a prioritizing effect. "If I haven't already moved it, do I really *need* it?"

(Hey, want some stuff?)

I've been on a reduced publishing schedule over the last couple of months, lest I fall into the annoying habit of blogging about agonizing about not writing about planning to actually do something, but that trend is about to reverse as I get back to work on the ship. This issue discusses the grand plan, along with a sampling of my favorite project resources (including other boat geeks).

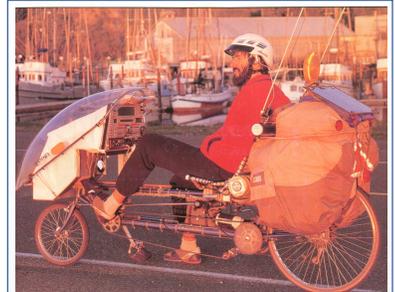
This is a fitting topic for the last issue of our first quarterly compilation, available in the next week or so as an ebook, and shortly thereafter as a full-color hardcopy edition. New subscribers will now receive issues beginning with #13.

-- Steve



Nomadic Research Labs

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About subscriptions

This publication is available as a weekly PDF for \$20/year... or quarterly eBooks & print editions. The price of the electronic version is low (only 38¢ a copy!) to encourage subscribing. Please visit the [Nomadness Report](#) page on our website to sign up with PayPal, Visa/MC, or check.

The photo above was from the *Bicycling Magazine* calendar of 1988. [Full photo](#) in the new [Anarchivist site](#), which is gradually accumulating all my old print and video media.

THE VOYAGE AHEAD

Long-Range Planning

For a while there, plans involving S/V Nomadness were on the vague side... hobbled by daunting logistical impossibilities (boat moored two hours from lab) and relationship challenges (despite the creative [two-boat solution](#)). Both problems have been solved, and the way forward is clear.

My focus is now on system projects that have been back-burnered for too long, and the rest of this issue will give you an overview of those. But the question everybody asks is, "where are you going?"

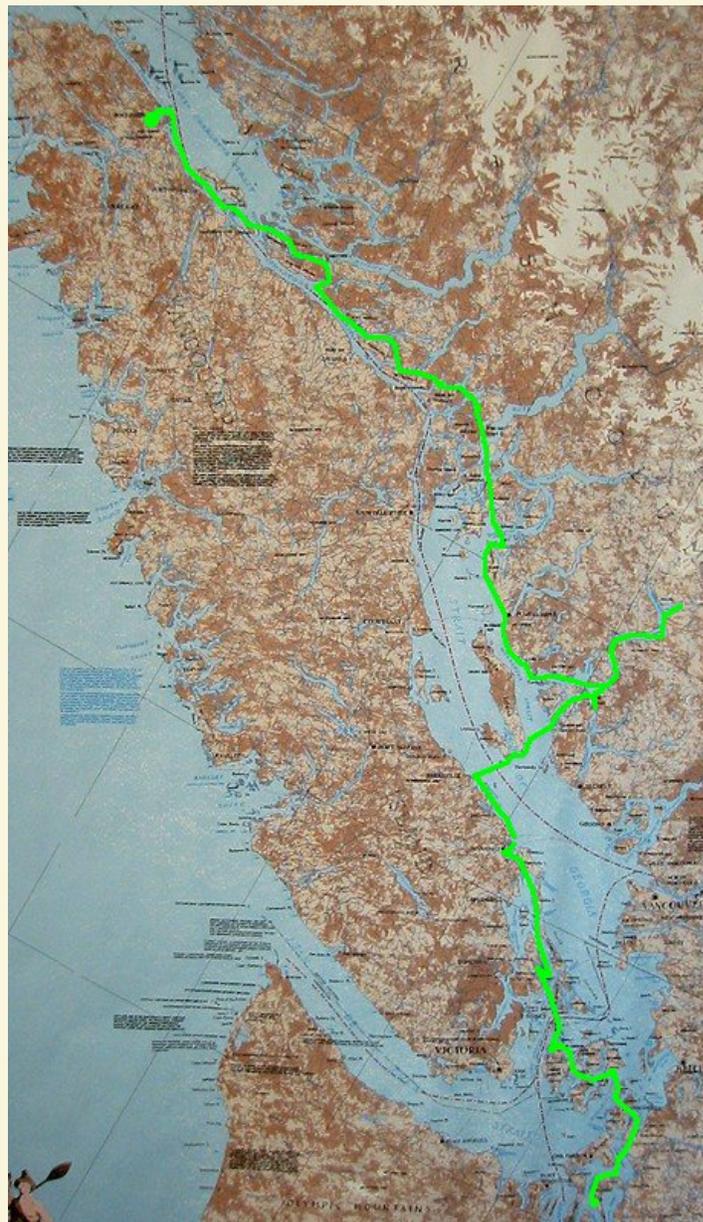
Well, I arrived in the Salish Sea 13 years ago because the cruising here is spectacular, yet I have done too little of it... so next summer will be devoted to getting out of my local comfort zone and into the more interesting waters north... beginning with the route shown at right. But then what?

After another winter wrapping up lab-based geekery (bootstrapping the on-board lab so I no longer need expensive rental facilities), we'll pick a launch window and head out the Strait, turn left, and make our way down the Pacific Coast (synchronizing with the [2012 Baja Ha-Ha](#)). We'll ride that floating party down to Cabo, then continue to the Panama Canal, traverse to the Atlantic, dodge hurricanes as needed, and idle through a Floridian/Caribbean/Bahamian/Bermudan winter until it's time to head up the Atlantic Coast.

We'll jump off from Nova Scotia and cross the North Atlantic to the Scandinavian countries (Kirsten's family is from Norway), then dodge winter in the Med. At that point, we can either loop back across the Atlantic via the Canaries and return home, or continue around the Cape of Good Hope, cross the Indian Ocean, spend quality time in Oz and New Zealand, then meander through the South Pacific in a way that follows winds and currents. The return to the Northwest, assuming we still want to, would be via Hawaii or the more northern reaches of the Pacific High. ([Key reference book](#) for voyage planning)

Of course, that's all pure hand-waving, and if I've learned anything from my technomadics, it's that if you think too much about where you're going, you lose respect for where you are. Still, it's nice to have a direction in mind, and that one is as good as any.

The real point is to live a life of voyaging übergeekery before it's too late... too late for any of a variety of reasons. Including mortality.



Summer 2012, Leg the First

As we look toward the coming "shakedown cruise," the obvious direction is north... between Vancouver Island and the Canadian mainland. I single-handed my Corsair 36 trimaran to Desolation Sound in 2006 (due east of the black text block); a few tricky rapids north open the door to the Broughtons and beyond. Our plan is to start with this, head up to Southeast Alaska, then return "outside" to get a taste of the exposed coast before settling in for final voyage preparations.

SELECTED RESOURCES

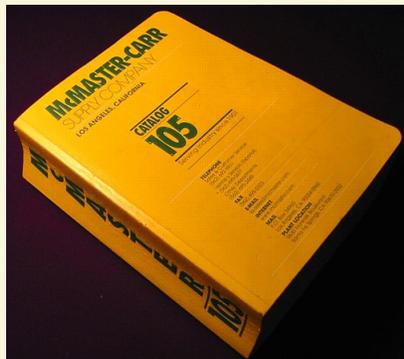
Here is a random collection of resources that I find useful... another geeky boat project, blogs of note, forums, online stores, and other tools.

McMaster-Carr

Every hardware-intensive shop, not so long ago, had the *Big Yellow Book*; indeed, if one's business were too small to be granted a free copy by McMaster-Carr, back issues could be found on eBay (I sold the one shown here for \$24). "Mickey Carr" is the ultimate hardware store, and many projects take shape thanks to the availability and quick delivery of, well, just about anything. And you know what you're getting.

In the past few years, the company has done a spectacular job of putting this online, with searching/ browsing tools that

let you quickly drill down to the part you need and add it to your order. This is a must-bookmark site for anyone doing a boat-hacking project... not the cheapest, necessarily, but definitely the best!



The Anarchivist

I've been having a ball with something that has been on my "must do" list for years... converting old media coverage, magazine articles, historical documents, and system documentation into an online archive.

Each item is inhaled via a [Fujitsu ScanSnap](#) and turned into a Searchable PDF... which is then

processed through Automator to yield an OCR'd text file and images of each page. These are used to create a blog post that carries the original date of the document, automatically forming a timeline.

It's good to rescue this precious old stuff from decaying paper... and I'm doing a similar thing with the ancient VHS dubs of bike-epoch media coverage, converting them via digital camcorder and iMovie into embeddable YouTube videos.

The collection has its own corner of my website called the [Microship Anarchivist](#) and will continue to grow... it's a nice short-attention-span background task.

(I just had to throw this in, even though it's not really a boat-hacking resource... not yet, anyway!)

Odda Sea - Life aboard an Allied Princess

Daniel, who blogs about his projects aboard *Alethia*, is a kindred spirit of the next generation... that much was clear when we had an hour-long chat a few weeks ago. That feeling has just been reinforced by his [excellent essay on the Maker spirit](#), which truly nails the essence of moving beyond our habitual state of thrall to the old-boy network of marine manufacturers, "professional installers," and industry standards that collectively thrive on the assumption that boaters are rich. He gets it.

The blog is yet young, but Daniel is an excellent explainer and does good work. This is one to watch as we build our boat-hacking community and collect the skills and resources to become more self-sufficient. He writes:

"As a society we still look to larger boatbuilding corporations, big names in design, and equipment manufacturers with specialty products instead of our own skills, community-available tooling, and a shared knowledge of technology and design. We look to our economic overlords instead of to each other."

It's time for open-sourcing to make its way into this community that is, by its very nature, free-spirited and nomadic. My own publications are in this spirit, and it is good to meet folks like Daniel who are running with this same vision.



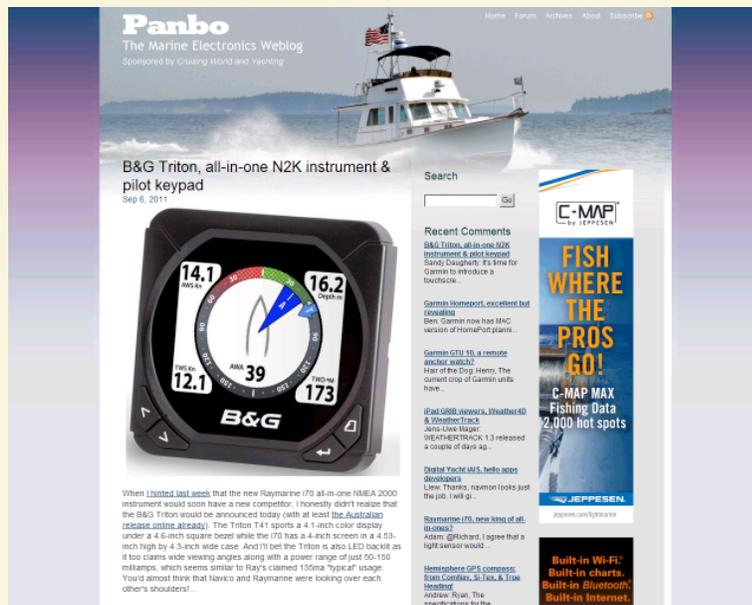
Daniel gives clear instructions for making these "soft shackles" out of Amsteel line, capable of replacing all the Stainless ones on your boat. I'm going to have to try this.

SELECTED RESOURCES

Panbo

As a boat geek with a serious case of GAS (Gear Acquisition Syndrome), I have a problem. In a very fast-moving industry that is constantly reconfiguring itself to seductive new technologies, how the heck do I keep up? I've already made the classic mistake a few times... buying boat-tech long before it's needed, then watching it grow boring on the shelf as it's surpassed by the Next Great Thing.

The best single resource I have found for keeping up with what's new in this field is [Panbo](#). Run by Ben Ellison, a prolific writer for marine magazines, this is devoted to the the gizmology of chartplotters, NMEA2000 instrumentation, AIS, communications, video, on-board computing, emergency signaling, lighting, entertainment systems, and anything else involving electrons afloat. I would never make a purchase without spending a few hours reading his posts, the comment threads, and associated forum. Open-source and maker issues on the previous page notwithstanding, this site is essential for boat geeks.



Cruisers Forum, Metal Boat, Sailnet, Hull Truth...

Blogs, even with a devoted author and clever commenters, are still rather well-behaved and ordered places, with subjects chosen by the blogger and discussion generally kept on-topic. I like the best of them for exactly this reason.

Still, there's an orthogonal ecosystem that is equally rich, with a wildness that results from a completely open forum structure. The successful instances of this have devoted moderators that snuff out flame wars and spam, yielding a rich breeding ground for discussion. These are four of my favorites, with [Cruisers Forum](#) a favorite hang-out ("Microship" here, with about 650 posts). This covers the whole range of cruising topics, from lifestyle to boat tech, and there are a lot of experienced people there.

The [Metal Boat forum](#) is much more specialized, as its name implies... with my Amazon 44 steel hull, that's the place I go for questions of coatings, corrosion, and maintenance.

I've never really moved into [Sailnet](#) as an active participant, but it comes up so often in searches that I mention it here.

And The Hull Truth has a strong fishing focus that doesn't really interest me, but their [Marine Electronics Forum](#) has a lot of excellent hands-on info.

There are many, many more out there... if you find one that feels like home, it's worth hanging around and building seniority.

Three Sheets Northwest

Not just a blog, not quite a forum... this is an interesting Wordpress-based hybrid of publishing resources, all focused on the sailing scene in this corner of the country. Naturally, that ends up including tech material, how-to articles, and a variety of perspectives... thanks to their "Guest Dock" that picks up content via RSS from a large stable of bloggers (including yours truly) and posts teasers.

The site is run by Marty McOmber and Deborah Bach, who are in the process of making the transition to a full-time life aboard, and they write well of the adventure. Coverage of Northwest maritime news is excellent.

There's also a "My Boat" series that features a different vessel every month or so ([here's the one about Nomadness](#)).



INHALATION...

As this issue wraps up the first 12-issue "quarter," not counting schedule slippage from moving, I thought I'd take this opportunity to talk a little about what's coming up... now that the new lab is established (though not yet well organized). News about that, and a few other things, is in my blog post of September 4: "[Settling into the New Nomadness Lab.](#)"

You'll probably be glad to know that hands-on boat geekery is starting up again... the stuff this publication was created for. At the moment, I'm reverse-engineering Yanmar diesel engine control panels, inspired by the need to find the cause of a spontaneous alarm that woke up everybody except me in the pre-dawn hours a few weeks ago. This should yield a more useful drawing than the cryptic one in the Yanmar manual, simplifying later hackage and N2K interfacing... unless... we manage to do a hybrid-electric conversion, obviating the whole problem.

It's way too early to know for sure if this can happen, but I'm exploring it. That would be the ultimate retrofit for this boat, changing its character completely, and I wouldn't look back for a moment at the loss of my big scary old Yanmar 4JH Turbo or the tired 3GM clattering in the genset bay.

In general, the project priority list is skewed toward things that need to be done to allow us to get happily off the dock... something that hasn't happened this summer, thanks to all the logistical overhead. Early projects involve lots of little things, unremarkable until completed: chasing leaks, bonding curtain magnets, mounting the water heater, repairing the shower seat, purging Webasto lines, re-rigging the dinghy hoist, finishing the companionway door, and installing a cat door in the shower. Yawn. But it's all

necessary; removing annoyances and fixing the little things is the first step toward sanity aboard.

More interesting are the two integral systems projects... power console and Waterworks (Issue #9). These will both go a long way toward cruft-elimination and establishment of a design platform for future work.

Power, in particular, is a big one. There is theoretically some welding being done on the solar array, the original breaker panel has a new home as soon as the new one is in, and the old AC console (nightmarishly unserviceable) is being folded into the new combined region at the inside helm, packed with Blue Sea panels.

This infrastructure will be messy for a while, but should yield a solid and well-documented framework for ongoing development.

Of course, that's when the *real* fun begins. The open area that was once a cramped dinette is awaiting the new lab desk (about eight feet wide) with integrated full-size piano

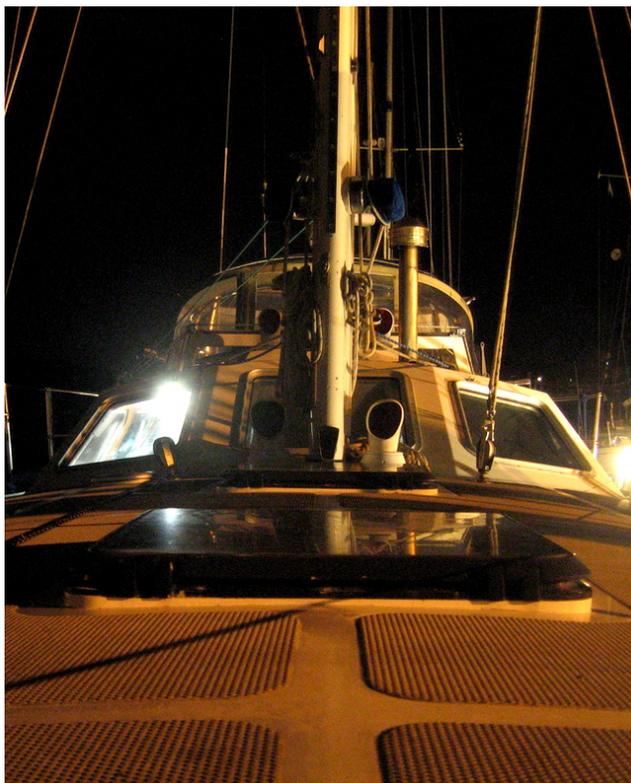
under a hinged cover and wrap-around sloping console. Segments of this control surface will be devoted to computer systems, communication gear, video, recording studio, and lab instruments. Each will be a standard 19" panel width, hinged at the bottom to a sliding substrate that pulls out for easy serviceability.

Underneath the desktop is the original bench seating, minimally modified to support one full-suspension file drawer, the wet/dry vacuum, & an oilless air compressor for tools and diving around the boat. Printed-circuit fabrication hardware, binocular microscope, 3D rapid-prototype machine, and office equipment round out this area.

Across the hall, blended into existing cabinetry, will be a standing workbench with machinist tool cabinet, a deep nacelle for power tools, excellent lighting, a vise, and small drill press. Drawers to the left of this and below the lab seat will carry parts inventory.

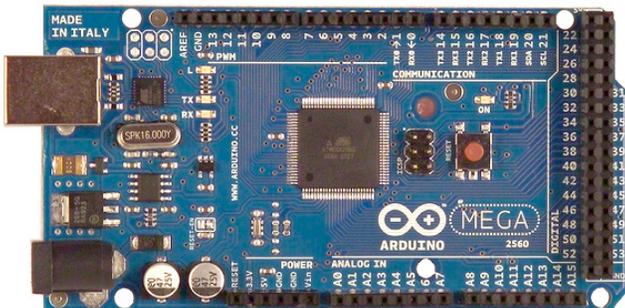
This is a lot to squeeze in, but it's powerfully alluring stuff... a big part of the whole driving fantasy behind this project. I'm often asked why I don't just GO, already - the boat is quite capable and I'm not getting any younger. But my peculiar twisted passion wouldn't be satisfied with that... like the bikes of yesteryear, I need to incorporate the geekery that pushes my buttons.

This is a pivotal moment, which is why I'm taking a page for what is probably a bit of a recap. The past few months have seen huge life changes, including a move from my facilities of 13 years, and the smaller digs adjacent to the boat are enforcing efficiency. Suddenly the project, for too long pushed to the background, is right here in my face... all day, every day. It's about to get fun.



SOURCES FOR GEEKY BITS

I'll close this issue with a few more comments on resources... specifically, the silicon bits that make our boat-hacking projects blink and dance. This is a whole different world from the "marine electronics" space, which, for all its magic, is oriented toward the end user



more than the geek.

Most of the embedded gizmology on *Nomadness* will be based on the [Arduino](#) platform, which has risen to prominence relative to other microcontroller standards largely because of its open-source nature. This has translated into a huge population of community participants, sharing their designs in a reputation-based economy rather than shrouding them in competitive secrecy. Ask a question on the Arduino forums, and you are likely to get sound advice, code snippets, pointers to other projects with similar solutions, and encouragement to report back on your results. This is quite different from some other communities, where the stern admonition to RTFM or "use this thing called Google" are likely to greet any newbie with the temerity to ask for help.

It also translates into a staggering resource of related hardware, mostly in the form of *shields* that plug

into standard Arduino controller boards. Why roll your own interface widget when you can get one for twenty bucks or so?

A bit of Googlage will turn up all sorts of suppliers, but my own favorites include [Sparkfun](#) (which has become a friendly superstore of geekery), [Adafruit](#) (products spawned by the creative [Limor](#) AKA [Ladyada](#)), and, well... about [110 others!](#)

If you're new to the world of rolling your own controllers, I highly recommend focusing on the Arduino. A number of good starting resources are over at [Make Magazine's blog](#).

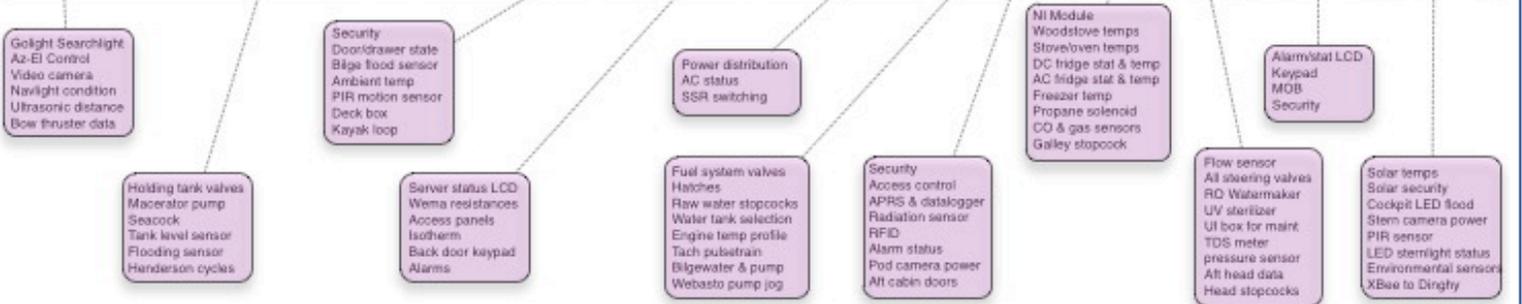
Access to random electronics is equally important, of course, and the two big superstores that welcome small orders from individuals are [Digi-Key](#) and [Mouser](#). Individuals can get frustrated with old-line distributors that actively discourage anyone without a purchasing department, but I've had consistently excellent results with these two... though I still end up checking eBay where there are countless suppliers who ship cheaply from Asia and have pretty much everything... I just got a hundred DIP latching relays from Thailand for a song, to be used in the new signal-agnostic crossbar matrix that replaces my old audio, video, and serial switching systems from the Microship epoch.

My own little store is a minor resource along these

lines... I haven't really been taking it seriously, but I'm a Sparkfun dealer and recently added the Arduino Inventor's Kit. If you are starting from zero and want to play with this platform, [\\$99 will get you started!](#)



nomadness



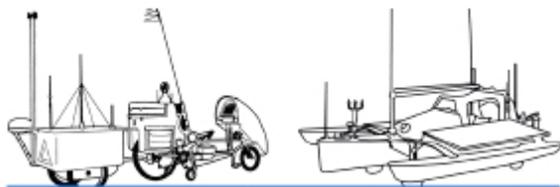
TALES OF POWER

Welcome to the first issue of the second volume; the first 12 *Nomadness Reports* are now incorporated into an eBook as well as a hardcopy edition.

The publication schedule is about to ramp up again... the myriad tedious distractions of selling my house and setting up new dockside facilities are now winding down, and boat projects are finally re-taking center stage. This includes fun stuff like lab/console design, the power-distribution panel, and a huge feasibility study on the question of converting *Nomadness* to electric thrust.

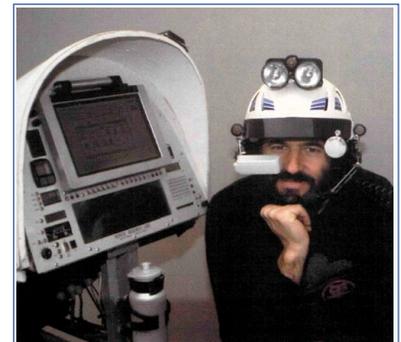
This issue carries updates on these things, as well as a special treat: an engaging tale of a successful first Arduino project by a fellow boat geek, Daniel Collins, whom we introduced on page 3 of Issue 12. After a speedy and successful learning curve, he ended up with a system that graphically displays his solar charging system performance. I'm looking forward to running more stories of applied gizmology on boats various... please let me know if you'd like to be a part of this!

-- Steve



Nomadic Research Labs

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The photo above was taken by Maggie Victor, and appeared in the January 1994 issue of *Internet World*. [The full story is in my archives.](#)

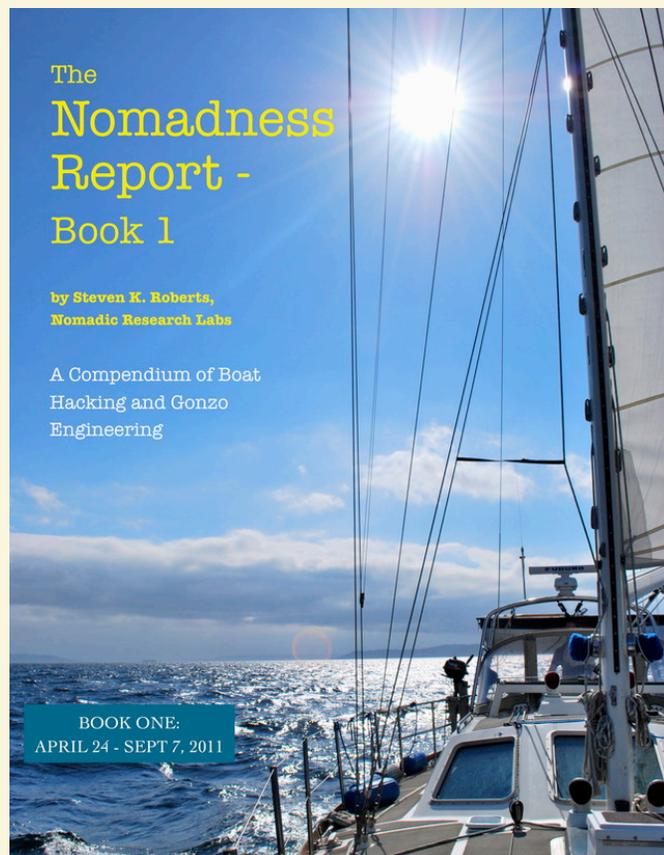
PUBLICATIONS OLD AND NEW

The First Compilation Volume

I wasn't sure how this was going to work, but knew as the first 12 issues started piling up that I needed to package them into a tidy unit. That has now been done, and I couldn't be happier with the results.

The electronic version is just a concatenated file of issues 1-12, with added front and back "covers," whatever that means in the digital domain. I used Apple's Preview app to do this, and it was painless... the result is a 27.6-megabyte file that is [available](#) for \$10 in my online store. The Zen Cart software automagically handles the download process.

I was more interested in seeing what would happen with the print version, since I've been intrigued by the MagCloud service ever since it launched. It's not cheap (20 cents per printed side plus a buck for perfect-binding), but I'm happy to report that the quality is simply stunning... I returned from the post office with my edity copy, grinning so broadly that Kirsten popped her head out expectantly before I even made it to the door.



I had been expecting that most of the images would have inadequate resolution, and was prepared to abandon the idea of a print version rather than re-do all 12 issues. But only one photo was jaggy (the Microship at the dock in Issue #7), and I can simply re-scan that one. There are also a few little layout glitches that need to be fixed, but no biggie.

The hardest problem I have to solve before releasing the hard-copy editon involves all those underlined hyperlinks. They look just the same as they do on the computer, but no matter how hard you jab the paper with your finger, they stubbornly refuse to open!

Rather than clumsily edit every page with footnotes containing full URLs, I think I'll add a section at the end of the dead-tree edition. For each page of the book, there will be a list with the anchor text (like "available" over there in the left column), followed by a short alphanumeric code. If the reader goes to a special support page for the book and enters that code, it will then open the associated link. Tedious, I know, but I can't think of a better way... QR codes would be sexier, but most folks don't have suitable tools available.

Anyway, once that problem is solved, this book will be a reality. Not including the added link-redirect section, it's 80 pages... though I can get a 25% discount if I buy more than 20 copies at a time. I figured I'd do that and offer them in my store for about \$20... which includes a profit of about \$5/copy.

I originally thought this would feel clunky compared to clickable and searchable PDF versions, but they really are surprisingly beautiful. How this translates into future sales, I have no idea, but I'll go ahead and produce a batch to see what happens.

The Anarchives

Meanwhile, ironically, I've been having a ball with conversion of ancient paper into the new archive site I mentioned in Issue #12. Now called [The Library of Applied Technomadics & Gonzo Engineering](#), it is up to 67 articles at this writing, automatically ordered as a timeline. There are some spooky similarities between the older projects and the current one, and it's fun to think of it all as one huge unfolding story instead of a succession of isolated projects. I'm including tech material (Bikelab Reports and such) as well as media, so there's plenty of geekery.

OK, on with the new stuff!

HYBRID CONTEMPLATION



In my case, the pump is somewhere down on the port side of the block near that bright white Halon fire extinguisher in the upper photo, and if I lie across the engine and grope blindly around, I can lay my hands on what I think is it. I watched a guy from Hatton Marine do this once, during a \$1,776 service call... pretty much feeling his way, chatting amiably the whole time, getting it done in ten minutes or so. This is what he does. (That's Sean on the right, there, giving me some tips on keeping the beast happy and concluding that the smoking



I haven't spoken of it until now in these pages, but there is one dark and mysterious part of the good ship *Nomadness* that sets up a tremble of unease in these old bones. Deep beneath the lovely teak-holly sole of the pilothouse lurks the *Hrududu from Hell*... the Yanmar 77-horsepower turbo-diesel engine (4JH-DTE).

Actually, as marine diesels go, it's really nice. It always starts, moves me smoothly at hull speed for less than a gallon/hour, and only smokes when idling cold. But I still don't trust it... partly due to my own lack of knowledge about diesel engines, partly because it has over 3,000 hours on it, and partly because it's really a pain to work on.

Take the dreaded impeller change, for example - a common maintenance task that one must expect to do at random times, often under unpleasant conditions. This is the case with any marine engine, and knowing how to deal with it is essential.

problem could be easily handled with injector re-patterning.)

While aboard, he draped himself over the generator in the photo below, a Yanmar 3GM producing 7,500 watts of sine waves, and replaced a dripping water pump somewhere down near the bottom of the deep well in which it's mounted. That job was hard, even for him!

I have nothing but respect for guys who can do this, but I'm not personally fond of engines... nor



am I comfortable poking around their innards. I know it's just another learning curve, and if I were to fling myself into it with the proper attitude and take one of the many classes available, my comfort level would rise considerably.

Diesel engines are solid and reliable machines, so they say (as long as you give them clean fuel and change the oil on schedule), but there are some high-precision, non-user-serviceable parts that are essential to their survival. In my big Yanmar, that includes the injector pump and the turbo, both of which are expensive and OLD. And while they haven't let me down yet, that doesn't mean I trust them.

All of which raises a big and expensive question. Education and ongoing maintenance, rebuilding, or repowering... what's the *best* approach for long-term reliability during years of open-ended global wandering?

Perhaps it's worth exploring an alternative...

HYBRID CONTEMPLATION

The question, of course, is what to do about this? I can't go gallivanting off in a state of thrall to machines I don't trust, and the *Geek Within* eyes this as an opportunity for an interesting upgrade to an electric hybrid system. But the trade-offs are mighty, and not everyone out there would agree that such a conversion is a good idea... especially on a boat this size.

There are many examples of successful repower projects on smaller boats... one very pretty website shows [Kopawai](#), a Catalina 30 with an electric system by [Propulsion Marine](#). A quick YouTube browse will turn up many others, and poking around forums various will start to reveal the depth of emotion around this issue. Let me share a few highlights of the brainstorm in progress...

A Quick Definition

A *series hybrid* electric propulsion system is conceptually very simple:

Instead of a diesel engine driving the propshaft, there would be a robust electric motor. Power is stored in a dedicated high-voltage battery bank, and a controller mediates the process to optimize efficiency and allow fine-tuning. A battery charger takes care of refueling.

If that were it, the system would be simple and relatively inexpensive... but the energy storage density of a battery bank is nowhere even close to that of a tank of diesel fuel. So the approach above is range-limited... though in some applications that is not a problem. If I were simply powering in and out of a marina to sail in a local bay every weekend, then that would be all I'd need and I could get rid of stinky fuels entirely.

In the real world of cruising, however, that's not enough. The *hybrid* term enters the picture when we add the other key component: a diesel generator optimized for high voltage, set to run at the most

efficient point on its power curve while charging the batteries or directly powering the motor.

Some argue that this is redundant; if we are going to go to all that trouble, why not skip all the fiddly expensive electronics and keep it simple? Is the constant-speed efficiency increase really enough of a savings to compensate for all the added equipment?

Well, no. But there's more to it.

Use Case Analysis

The benefit of an all-electric mode with a few hours of run time is that a fair percentage of engine use fits within that profile. Though I've personally been lazy more times than I want to admit, motoring all day in a breeze just to make port at a predictable time, it's not difficult to imagine treating the sailboat primarily as a sailboat... using the motor for all those short bursts of activity that happen every day: close-in maneuvering, zipping across a shipping lane, plodding upwind in a narrow channel, powering off a lee shore, having directional control while hoisting or stowing sails, motorsailing, and dealing effectively with places like Deception Pass where you have a narrow window of slack and lots of rock on both sides.

And with all those short-term auxiliary power needs, the *worst* thing you can do to a diesel, say the experts, is repetitively fire it up and turn it off after a brief run that doesn't reach and maintain a healthy operating temperature.

So a hybrid system is ideal for this scenario: mostly sailing, but getting guilt-free help from the "iron genny" whenever needed. It's always on, and trivial to use.

Scaling

The other scenario is the all-day plod at a steady 2800 RPM, making hull speed hour after hour in windless conditions (or worse). Many times I have looked up with a sigh at my 60-foot mast raking the sky, the engine droning, wondering

why I bother with a rig at all. Of course, that crazy thought evaporates the moment she gets a bone in her teeth and begins the graceful motion that makes you just want to go on forever (see the short video just down the page on my [blog post of May 2009](#)).

But sometimes there's no choice. What then?

For a hybrid system to make sense, the generator's output and collective conversion losses have to net out at something close to the original powerplant... at least long enough to deal with the kind of [emergency](#) that can arise without warning and require steady power to save the boat. This means the new genset has to be more than just a battery charger; it has to be a serious piece of equipment, right up there with the stuff that would be ripped out to make room for it.

These are the kinds of things that get folks arguing on the forums...

Aesthetics

Hard-nosed practical issues aside, there are other factors. Frequently cited by electric boat enthusiasts is the lack of noise and smell... that sounds pleasant to me. Imagine having a conversation in the cabin while motoring...

More esoterically but just as important, my own geek expressionism and sense of beauty thrills to the notion of shiny clean small things in the cavernous greasy space that once held the Yanmar, with a battery drawer disappearing into the currently inaccessible region under galley and nav station (behind the engine compartment wall at left in the top photo on the previous page).

Can the cost analysis make this work, including new prop and serious hackage? Is it realistic for my 18-ton ship? Are there issues with noise or serviceability that I have yet to discover?

Investigation is underway, with a vendor I have yet to mention in these pages. Stay tuned...

AN ENERGETIC ARDUINO TALE

Geeking Out *Alethia*

In Issue 12, I introduced [Daniel Collins](#), who blogs about adventures with his *Allied Princess*. We are on rather parallel paths, with similar attitudes, and I wish he were a dock neighbor instead of way off in Texas somewhere.

Daniel bought an Arduino-based Sparkfun Inventors Kit from my online store (\$99, plus another \$15 or so for an LCD), with an eye toward kick-starting his learning curve in microcontroller development. Well. I think it was only about 2 weeks later that I heard about a nicely designed solar charge monitoring system... so I invited him to tell you about it himself. Take it away, Daniel!

Meeting the Arduino

I've always been interested in what engineers call "embedded circuits": the microchips that run your GPS, your car's engine, and your stereo system. These smaller siblings to the PCs and Macs you and I use on a daily basis are still fully capable computers in their own right, but are designed specifically to do only a handful of tasks at once, without needing user interaction or intervention. In short, they are highly reliable, customized, and purpose-built circuits and software that can be made to do an amazingly wide variety of useful tasks. However, up until recently the ability to really make use of these embedded devices was beyond the range of your typical person, well into "über geekdom". That all changed with the introduction of a series of less expensive and more user-friendly kits such as the PIC series, the ATmega series, and most recently the Arduino project, from which a whole host of new and specialized kits have begun to evolve. I hadn't heard of the Arduino series before, but when Steve mentioned it in a recent *Nomadness Report*, I had to look it up, and when he listed a nicely packaged introduction kit in his store at a very fair price, I jumped on it because I had a devious plan for a first-use scenario aboard my boat...

You see, Steve has been talking for a while about his various plumbing sensors, dataloggers, and boat network devices, all taken from concepts he developed from his time with the *Winnebiko* and *BEHEMOTH* but using newer gizmos and technology to help simplify and standardize the components. When I first heard about his approach, I thought: "could I make a datalogger that stores my power generation and usage on an SD card for later charting?" Turns out, this kit was exactly the jumpstart I needed to make this little gizmo a reality.

The kit itself was not everything I needed to do the job, but it was a fantastic start: plenty of useful components to give me an introduction to the Arduino platform, some time writing simple code that teaches the fundamental structure of the software, and plenty of little gizmos to assemble in various ways. All lots of fun, and quite useful on their own, much like a Lego set for adults, only the pieces can be taught to sing, dance, and generally whir and buzz about to various inputs such as buttons, sliders, and light sensors.



But I wanted to take it a step further: I wanted my Arduino to listen to the digital data coming from the control port on my solar charge controller and decipher from it how much power came from the solar panels, how much power was going into or out of my batteries, etc. I then wanted it to write all of that data once every couple seconds into a computer-readable file on a small SD card much like the ones in your portable cameras or cellphones. Sound too complicated? It really wound up being a lot of fun.

Planning

Effectively, I broke the entire process down into a series of simple steps that added "building blocks" that I needed. Each step would both teach me something new about Arduino and the components (SD card, LCD display, RS-485 network, etc) that I was trying to interface to it, and give me a bit of code that I could use to incorporate that component into the overall system I was building.

Since I was starting with Arduino more or less from scratch, I began by going through all the lessons that came with the kit. With my engineering background, this didn't take too long, but it was still fun, and a nice fun way to get introduced to the way these devices work. While going through these lessons, I picked up

AN ENERGETIC ARDUINO TALE

a number of clues as to how I would need to be structuring my own project.

After that, I searched the Arduino forums and libraries for similar types of projects. The NMEA and TinyGPS libraries proved to be very useful in *reverse engineering* the way other people solved similar problems by looking at their code and figuring out what it did and why they wrote it. This is where a bit of my software background helped, but I have no doubt that someone with a moderate programming background would have been able to pick it up relatively quickly. If not, the forums are VERY helpful at bringing new members of the community up to speed - another big advantage for Arduino.

Once I had a general idea of how I needed to organize my code, I needed to figure out how to get the raw signal on the data wires into the Arduino chip. This was a pretty easy decision: the protocol that my solar charger uses is based on RS-485, which is well documented. A quick Google and a couple forum searches later and I determined that I could use a MAX3442 RS-485 transceiver chip to convert the RS-485 signals to normal TTL serial, which is what the Arduino chip uses natively.

Inhaling the Data

Taking things one step at a time, it was pretty simple to wire the RS-485 chip, load some very basic serial port debugging code that came with the Arduino, along with a library called `SoftwareSerial` which allows you to use other pins on the Arduino as serial ports other than the standard 2 pins that it comes set up for. With this library I could also design a custom serial port speed, since the baud rate on the RS-485 bus was NOT standard; I needed to interpolate a few values and plug them into a lookup table.

At this point, I finally could verify that I had raw binary data from the solar charger coming into the Arduino. Now I needed to "teach" it how to interpret the data as useful values (e.g. from 10000100 to 0x84

to 13.2), assign meanings to those values (e.g. 13.2 volts at the battery terminals), and then write the values to the data card. I placed a call to the vendor and asked (politely) if I could get a copy of their data specifications. After some conversation, they determined that I was not trying to steal their code or compete with their business, and so they agreed to send the data.

Vendor Relationship Advice

I should note that if you need to ask a vendor, it pays off big time to use a great deal of discretion and understand whether or not they consider their data to be in some way secret or confidential, and to respect their confidence in return by not sharing their data unless they are ok with it. This includes posting parts of their spec or your code to forums. I also recommend that once you have their documentation, regardless of how obtuse it is, you make every attempt NOT to bother them with technical questions unless it's absolutely necessary. By making it easy and agreeable for them to provide the specifications, you help everybody else who would call that same vendor in the future, and continue that vendor's good experience with the DIY community. It's thanks to their help that I was able to get the specs for the data so easily, and we should all respect the time they take to help us as well as their copyrights.

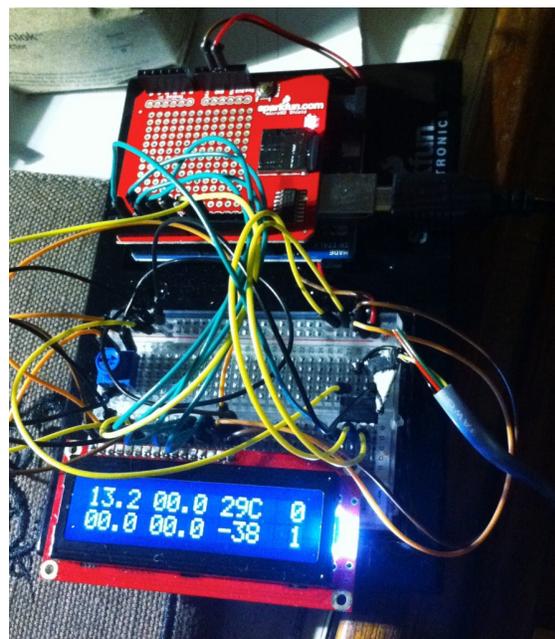
Programming

Writing the code to interpret the data was more tedious than hard thanks to a few subtleties in the specification as well as my learning curve with the limitations of the Arduino's memory footprint and some C++ language issues (what, you can't return a `char[]` array from a function call and expect the data to be good? `printf` doesn't check the length of the buffer it's handed? what is this pointer nonsense and why does an array

not behave like other variables?).

Let's just say it was a highly compressed education in fundamental computer behavior, but nothing terribly difficult. In fact, it was really a lot of fun since I treated it as a project and a puzzle, not as a job or a goal. If I made it work, great! If not, I'd find something else interesting to do with it. Being able to be relaxed and see it as fun was essential to the success of the project, and honestly the great forums, friendly folks, and extremely good introductory lessons and development environment were absolutely critical to making it FUN and not hard, annoying work.

And the outcome was fantastic! The SD card code was dead simple; in fact, it was provided with the SD card reader I purchased, and hooking it into my program was trivial after all the other programming I had just gone through. Once I set up the datalogger, I also attached an LCD display which Steve had thoughtfully mentioned I should consider, and used it to display the realtime data as it was coming "down the wire" so to speak. That way I had both a visual, human-readable display of my solar data in real time, as well as the logged history of the data being written to the SD card. Here's what it looked like:



AN ENERGETIC ARDUINO TALE

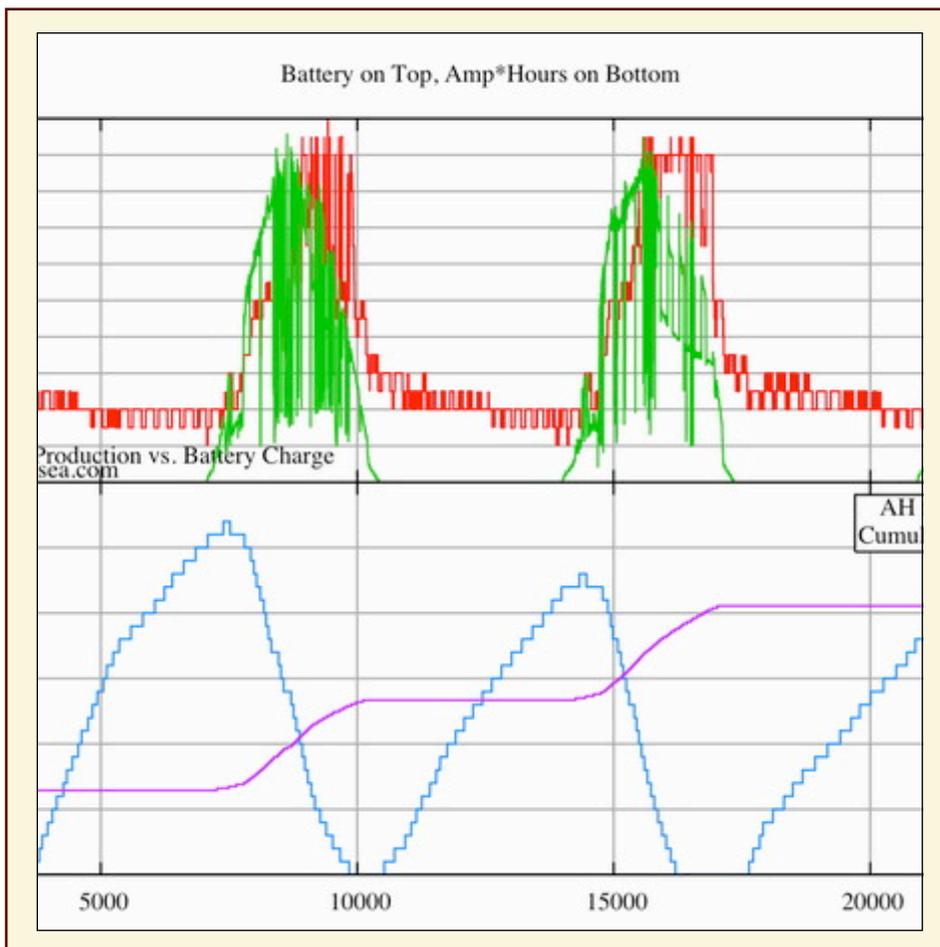
The two-wire RS-485 interface to the solar charge controller is coming in from the right hand side (the yellow and black wires in the 4-wire phone line) and going to the MAX3442 RS-485 chip (incidentally the same chip that can be used to properly interface to NMEA 0183 systems). The display is the current values (without text headings, I'm sure it looks a bit confusing), and since this was taken at night when the solar panels weren't producing any power, there are a lot of zeros. The Arduino and the SD card reader are linked together in the upper part of the picture. Most of the wires are for the display - only five of them belong to the RS-485 interface and only one goes to the Arduino.

As the final step, I took a few days' worth of data that my Arduino had logged and ran it through a fantastic graphing program called Gnuplot, which produced the chart you see at right.

The Output Graph

Effectively this is a chart of two things: on the top is the battery voltage (in red) and the charging current into the battery (in green). The volt scale is on the left, the ampere scale is on the right. The chart is all "wiggly" (as my friend humorously called it) because the solar power produced was continually varying as clouds skittered across the sky, the sun moved along its daily arc, and various other things happened throughout the day to cause the sun's intensity on the solar panels to vary. But the trend is clear, and each of those green and red "humps" indicates one full day of charging. You can see the battery voltage in between steadily decrease as throughout the night as my lights, refrigerator, and various other systems consumed some power before the next day's charging cycle begins again.

On the bottom half, the picture is even more clear: the blue line is the amount of power that has been drained from the battery (when it is zero, the battery is fully charged, when it is positive, the battery is empty by that many amp*hours). The purple line is the cumulative amount of power the solar panels have generated to that



point. So at nighttime, that line is dead flat, since the panels are adding zero power. During the peak hours of the day, that purple curve skews upward visibly, as the panels pack the power into the batteries, then trickle off as dusk approaches.

And so, in one simple graph, you have the entire complexity of the solar charging system, a visual representation of sunlight on the array, some very useful data for determining if your panels are sized properly, how close to the edge of your system's performance are you pushing them (in my case, very close), and how much power are you really getting versus how much you are using. And thanks to this gizmo and about a week of evenings, I can track this data all the time. The only thing remaining is to find a little water-resistant case to pack the Arduino into to permanently wire in

alongside the boat electronics - and that's a dead simple task compared to what I just described!

I already have many other ideas for how to use these little gizmos, so stay tuned for more updates.

Afterword by Steve

Dude! That was awesome... first project out of the gate with a new microcontroller platform, eh? If you ever want to move your boat to the Pacific Northwest, you're just the kind of co-conspirator I need.

*Hopefully we'll be hearing more about your projects as they unfold... and let this also serve as an invitation to others. This may be called the Nomadness Report, but the subtitle is the real spirit here: **A Compendium of Boat Hacking and Gonzo Engineering.***

The more perspectives, the better...

PREPARING THE LAB ZONE



Finally, I'd like to give you a quick preview of the segment of *Nomadness* that is about to be converted into a lab (including, very likely, off-the-shelf 19-inch rackmount enclosures that could really speed up the process of infrastructure-building). My next task is to cobble together a temporary desktop of scrap plywood and a cardboard mockup of the consoles, then spend a few hours playing "let's pretend" to get comfortable with human-factors issues.

The photos above show the area that used to feature a cramped dinette, with stiff blue cushions and no leg room for a big galumphing guy like me. The drum throne is about where a decent chair (Aeron, perhaps) will be attached, and the existing seat platforms will be pretty much unchanged... the outboard one housing an oil-less

compressor for air tools and diving, the aft one providing a home for the central shop vacuum. The desk width is nearly 8 feet, with a small wing at left (aft), and it's almost 18 inches above the existing covered bins... providing great stowage space for movable boxes and bags. Other than a file drawer forward, I don't expect this project to involve major carpentry.

In an upcoming issue (soon, I hope!) I expect to have a report on the CAD modeling (cardboard-aided design). If all goes well, the next steps will be a permanent desk structure and acquisition of the four rack cabinets... unless my woodworking guru convinces me that they should be built from scratch for maximum beauty.

Cheers from *Nomadness*, and I'll be back soon!

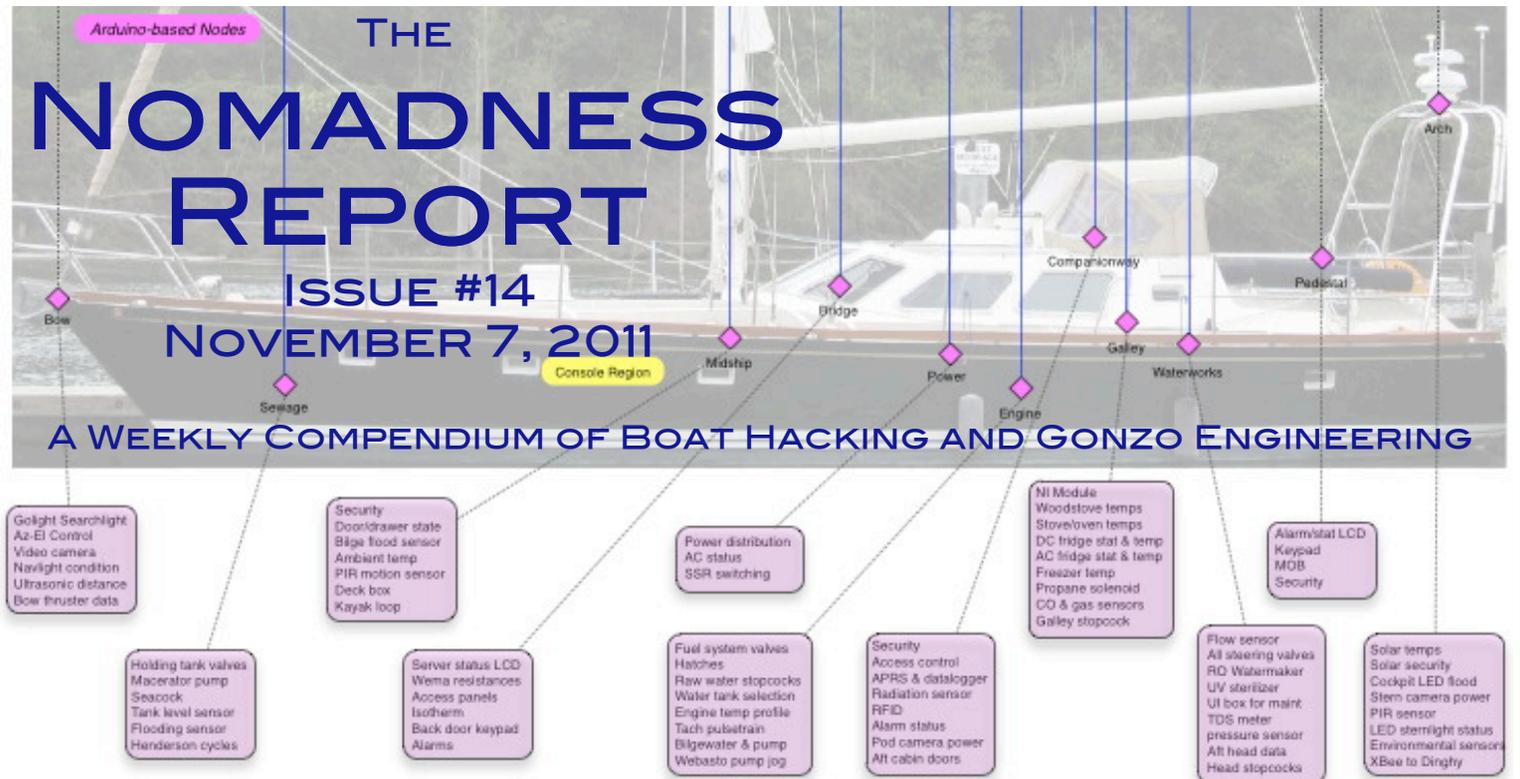


THE NOMADNESS REPORT

ISSUE #14

NOVEMBER 7, 2011

A WEEKLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



BACK IN THE SADDLE AGAIN

Huge news on the *Nomadness* project front... the house and lab on Camano Island have been sold. It's an unconventional deal, with me carrying the note, so no big chunks of cash for large-scale boat goodies (alas), but at least the ongoing expenses should be covered for a while...

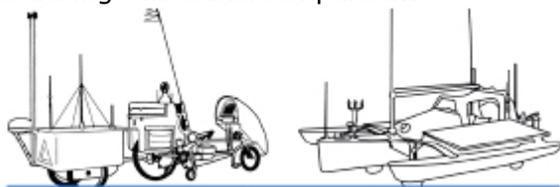
This further focuses the project. There is yet plenty of dormant tonnage at the old place, but all the core equipment (including mobile lab content) is now in La Conner at the head of the dock. So onward at last.

In this issue, I want to talk about a sort of grand perspective on this hugely complex system, and bring you up to date on the key sub-project that is currently receiving attention... immersive visualization of the lab region. I'm not one of those people who can successfully design an ergonomics-intensive environment on a CAD system, manipulating Mr. Template. I have to sit there and *feel* it.

There is also a parallel project flickering to life that will redefine the forward head compartment, turning it into a lab of a different flavor.

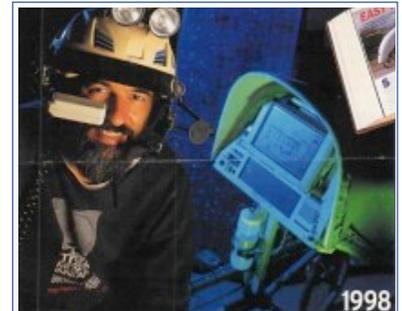
Best of all: the publishing schedule is cranking up again! Sorry for the infrequent reports during this transition period...

-- Steve



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The photo above was from the December 1998 issue of [Home Office Computing](#). (Click for story... this is randomly chosen from 96 articles currently in the archives.)

A SINGLE-SYSTEM PERSPECTIVE

The Perils of Segmentation

As the conceptual components of this daunting project have been shoved to and fro over the years, they have by nature become segmented... and here there be dragons.

Imagine all the arbitrary boundaries and overlaps. *Power* is a good example: it's one big chunk that has always been on my radar, further broken down into *Battery Management* and *Distribution*. But if you really think about it, both of those are woven so deeply into the rest of the ship that any attempt to draw a box around them immediately carves out (or calves off, depending on your perspective) sub-categories more logically associated with other systems.

This may not sound like an important issue, and indeed there are clear enough "edges" when it comes to physical panels and schematics that I don't spend much time fretting over ephemeral classification ambiguities. But it still leads to a sort of sloppiness in the project-management domain: is this piece of the puzzle a packaging task, a power distribution job, or just the upstream DC connection to that subsystem *over there*?

It may seem that the more neatly I can parse this huge system into a tidy hierarchy, the easier it will be to visualize... and thus, to build. But not so fast.

Fundamentally, what we are talking about when designing any huge interconnected system is the need to reduce complexity. If a project has the opposite effect, then it ventures into the domain of wankage - cool in a geek sense, but not very helpful when it comes to effective day-to-day operation.

It does not follow that a segmented design process will necessarily yield a choppy user experience, but things do have a tendency to go that way despite our best intentions (I've done it). The components take on lives of their own, with their various

interfaces and affordances defining our view of them... as well as the way they interact with each other. Indeed, we *must* think of things with this kind of object model, lest the entirety turn into a giant mass of spaghetti.

The problem is that a complex system presents design problems at every level of magnification. This easily translates into a "sliding scale" of interface design, with one extreme a well-conceived object-oriented chunk of code (where development tools and geek-cultural norms enforce discipline). But when you step back from this utopia of bits, you find a box with hard edges and arbitrary behavior, nestled into a complex application environment that incorporates not only other subsystems developed in parallel, but multiple incarnations of unrelated concepts from third-party vendors, orthogonal cultures, previous technological generations, cobbled gizmos of necessity, and random glue.

Suddenly the elegance of the Big System is a function of the level of magnification with which you approach it, and, well, that's just confusing.

Nightmarish Imaginings

On *Nomadness*, this phenomenon might manifest itself as an elegant yacht with traditional user-interface affordances (lines, pedestal, winches), augmented by a complex multi-generational aggregation of marine electronics: chart plotter, autopilot, nav/ weather instruments, radar, power systems, engine controls... interfaced, if at all, via a melange of protocols new and old. In the background is a panel of circuit breakers, and scattered here and there are little control panels, valves, through-hulls, and stand-alone electronic modules... none particularly well documented.

Added to this, thanks to years of obsessive effort reflecting designs and purchases scattered along the timeline of a rapidly

evolving industry, we might find a second technological overlay: a console system in which are embedded a variety of radios, computers, networking tools, audio production gear, lab equipment, and homebrew gizmology... along with a database-backed server with a dozen or so nodes around the boat contributing data. Atop all this (assuming I get around to it while still alive) is a rich layer of software intended to bring it all into a single conceptual space.

And it's all intended to reflect the dream of a cohesive integrated system, reminiscent of the starship *Enterprise*. "Computer... report!"

OK, what's wrong with this picture, other than sounding like something that will never get finished?

An Experiment in Conceptual Cohesion

A key component of my work on previous technomadic substrates (most notably, *BEHEMOTH*) has been the avoidance of wheel-reinvention through the expedient of taking one product after another and incorporating them into a general toolset. This typically involved serial and audio crossbar networks, hacking power supplies and original manual controls to allow load shedding and software-driven operation, and otherwise shoehorning a diverse range of gadgets into a single environment.

That's pretty much what I'm doing here, and in some ways it's easier now... most of the gadgets that I need have better tools for remote control than their counterparts of a quarter century past. With a signal-agnostic crossbar network and a bigger power budget to accommodate things that need an IP stack, it should not be too difficult to make anything talk to anything.

But here's the problem: all that is limited to my own geek overlay onto the existing ship. Naturally,

A SINGLE-SYSTEM PERSPECTIVE

that will incorporate the NMEA2000 network and I/O from independent subsystems, but one of the biggest chunks of this whole project boils down to plain old interfacing: using Arduino nodes and trivial sensors to bring everything under the aegis of the central server (see the "Shacktopus Overview" in Issue #3 for more context). I'm not fundamentally changing the design of all the systems made by other people, just slurping them into my microworld.

This is a considerable oversimplification, though it appears to be the solution to the problem: interface the hell out of everything, wrap it in code, and cast off the docklines with a tablet-based GUI added to the list of traditional yacht affordances. Tighten that winch. Head up a few degrees. Pinch to zoom that video image from the masthead, and verbally inquire about the ETA at our next waypoint.

But let's look at how all this impacts the development process, including the ongoing maintenance issues of replacing ailing or obsolete subsystems. If we get to control *every* aspect of the design, then this would not be a problem... but I am annoyingly finite, and would not reinvent all these arcane wheels even if I had the time and skills to do so.

Back in the Microship epoch, I developed my network of controller nodes in FORTH... a lovely vocabulary-based language that embodies a "bottom-up" programming methodology that makes testing trivial and enforces clear chunking of functionality. I found myself adapting the same philosophies to hardware design, trending toward clearly defined circuits that do one thing well and have precise interface specifications.

We don't have that luxury when trying to assimilate huge

complex systems made by other people... so the broad character of this project is starting to emerge: *All we have to do is become intimately familiar with every system (both now and in the future), write the tools to bring it into our current paradigm, create new hardware for every un-augmented device or data point of interest, create a database standard and a metaphor for*



dealing with this "internal model of the ship," and cobble interface code that works from every connected device ranging from tablets and phones to voice and packet radio. All that, and packaging too.

No problem.

Single-System Perspective

This convoluted philosophical sketch brings us back to the point of this article: if we're going to take on something this absurdly ambitious, it is essential that we

think of it correctly. If there is an attempt to accomplish all this by outlining a collection of isolated to-do list items, each defined by the flavor of the target device and the software tools *du jour*, then it is going to be nigh impossible to avoid a gradual emergence of the scenario I imagined above... so many different concepts in the same system that I can neither keep it all in my head nor successfully document it.

The solution, I believe, comes down to the way every task is contextualized. This almost sounds like HMB (Hip Metaphysical Bullshit), but it's true: when we build machines, they become the crystallization of our dreams. Get the dream right, avoid letting the tools shape our work, and keep the big picture in context... and we at least have a shot at creating something that reflects our design objectives.

What does this mean in pragmatic day-to-day terms as I resume focus on the boat? Just this: *Nomadness* (or any huge convoluted system) is not a collection of subsystems as much as it is a single entity. The temptation to treat the project as a massive hierarchy of stand-alone sub-projects is dangerous, for the inevitable conceptual drift will change the flavor from one to the next. The solution boils down to two things:

- ☑ Keep a clear dream uppermost in mind, even if that requires reducing it to an "elevator pitch" so it is not vulnerable to creeping featuritis.
- ☑ Make sure every task is colored and shaped by that dream, and is not allowed to wander off into the seductive domain of its own intermediate objective.

Let's put a practical spin on this, then get back to specifics!

ENGINEERING IN A NUTSHELL

This little snippet about how engineering really works was from my aborted *Inside Microship* book a decade ago, and is still annoyingly relevant. Here's how to manage a huge, complex project:

1. Accept going in that your first tentative decomposition of the fundamental concept will yield an over-simplified TO-DO list, distorted by misunderstanding of key issues.
2. Avoiding all the items labeled TBDWL (To Be Dealt With Later) or ATAMO (And Then A Miracle Occurs), dive headlong into the well-defined parts, finishing some of the electronic design so early in the game that it is guaranteed to be obsolete before the physical substrate is built.
3. Blunder ahead on the non-obvious parts, getting pleasantly distracted by learning curves and occasional moments of certainty, only to discover basic flaws in your reasoning.
4. Now that you are forced to re-think the initial concept, map it onto newly recognized reality to yield a fresh TO-DO list (with new lab notebooks and computational tools to keep things lively) and another cycle of enthusiastic activity
5. Repeat steps 3-4 countless times at varying levels of abstraction ranging from the entire system down to individual components.
6. Meanwhile, since technology evolves with frightening rapidity, acknowledge the fact that any computer-based system is such a moving target that if it's not completed quickly, it will be irrelevant by the time it ships.
7. Respond by simplifying the design, further refining your objectives and abandoning dead-end ideas while doggedly pursuing others that have come to represent too large an economic or emotional investment to allow a graceful retreat.
8. Compromise here and there, bang out a few things that weren't on the list, then add them and cross them off to make yourself feel good.
9. Get totally sidetracked a few times, and periodically dive into major development marathons to meet public deadlines like trade shows, pulling all-nighters in PFD mode (Procrastination Followed by Despair).
10. Announce new completion dates whenever a previously predicted one has passed, and keep driving your PR engine to maintain interest during a process that is a textbook illustration of *Hofstadter's Law* ("Everything takes longer than you expect, even when you take into account *Hofstadter's Law*.")

Part of this development heuristic is just sloppy management, but it also reflects the way we think. This is why engineering is, at its heart, an art form (and why the average completion time of a homebuilt boat is 137 years).

Perhaps the most interesting thing about this seemingly ugly process is that it's iterative and self-correcting. Grandiose or stupid ideas may not be obvious during first-pass blue-sky analysis (when the project is glued together by wishful thinking), but it's another story entirely when it all has to be converted into Clearly-Defined Tasks (CDTs) and drawings that make sense to machinists. Without some kind of closed-loop intellectual process to fine-tune your thinking, it would be impossible to get to the point where you can start using engineering tools to convert fantasies into contraptions.

Trying to shortcut this by starting on Day One with formal design methodologies can have the catastrophic effect of committing you to an ill-defined goal state, whereupon the end result is shaped more by your toolkit than by the supposed objective. That's why so many products seem malformed, patched, and otherwise inelegant: management loves formal methods and looks askance upon such frivolous notions as approaching product design as a delicate blend of art and engineering. The exceptions, when they occur, are a joy to use. The rest miss the point, no matter how stylish their exterior or sophisticated their underlying technology.

So it appears that designing a system isn't nearly as rigid a process as typical engineering textbooks would have you believe. Your component choices affect the shape of the thing you're building; said shape in turn creates constraints that affect your choice of components. Such psychological race conditions can only be resolved by tweaking the granularity knob while adding inputs to your evolving mental model, until the correct solution congeals in a flash.

It's easy, and here's how to do it: Prop your feet up on your desk, relax, and form a fantasy of the desired results. Now turn it slowly in your head while calmly examining it from all sides, allowing input variables to float until an unanticipated combination satisfies your psychic fantasy-comparator and generates a flash of recognition. Since all your noodling is naturally saved in a big circular buffer called short-term memory, let this recognition event pre-trigger a snapshot of the conditions that immediately preceded it (before accumulated pondering-propagation delays introduce conceptual drift). There's your design specification. Take that and run with it.

This is probably not an engineering methodology that makes managers comfortable, though it's a good summary of life in the trenches. There is a pervasive myth that structured methods and sequential procedures, used in isolation, will get you there... but I've never seen it work that way. The tools don't actually start to become useful until you're quite thoroughly immersed, and that can take weeks of appearing, to outside observers, as if you are loafing.

CONSOLING THOUGHTS

The most practical projects right now, as I finally turn my full-time attention to the boat after this crazy summer of life changes, are in the infrastructure domain: new power panel, waterworks, and the on-board lab/console packaging. The latter has the distinction of being the one that can be immediately leveraged to help with work on the others, so it's in the foreground.

The next issue should have photos of the current activity (which is rather fun): a full-size mockup aboard the boat, with plywood desktop and a wrap-around sloping console of hot-glued cardboard. I've mentioned my CAD system before... cardboard-aided design... the absolute best way to design a workspace is to model it with cheap materials, crawl inside, and play *let's pretend* until weaknesses are revealed.

The desk is 88" across, and the four rack spaces are each 12U (20" tall). They wrap around my central workspace; if the *Communications* console directly ahead can be referenced as 0 degrees, then there are 45° and 90° consoles to my left and 45° to my right... with a machinist's tool cabinet past that to complete the symmetry and optimize workspace next to the *Lab* console. The two at left are devoted to *A/V Production* and general *Systems* (the latter being most accessible from three sides and visible from the pilothouse). All this will make more sense with photos and a proper drawing.

One of the big decision points at the moment involves the fabrication technique; I was getting tempted by the 12U ATA Effects Rack from SKB, used by traveling musicians and familiar to roadies. The beauty of this approach is automatic modularity, shock isolation, and gasketed covers... but they are black molded plastic, fully vertical, and about \$350 each. I prefer a little slope and a wooden exterior to flow nicely into the boat interior... with detachable gasketed covers for those times when the spray is flying. In other words, it has to be art.

Lumens... so many Lumens...

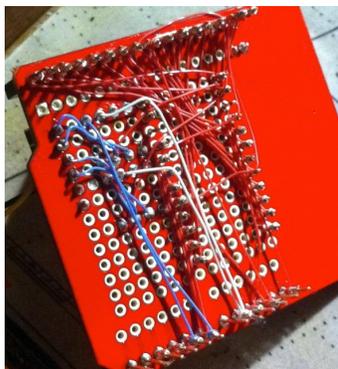
I've been annoyed by a lack of good utility lighting for a while, and my collection of LED flashlights is taking on a "retro" character (which, in this industry, translates into "dim"). I do have a monster handheld spotlight, but that's for rescuing crew overboard and other emergencies... not for every day carry (or, as the flashlight geeks at [CandlePowerForums](#) call it, EDC).



Well, this monster is my new serious light - the [Fenix TK45](#). It uses eight AA batteries ([Eneloops](#) are my favorite, with Maha [C9000 charger](#)), and has four brightness levels ranging from 8 to 760 lumens... along with a beautiful and practical beam pattern for working or walking (more a flood than long-throw spot). And there's a strobe mode that will completely disorient an assailant. The tiny one-AAA version is on my keyring - a [Fenix E05](#).

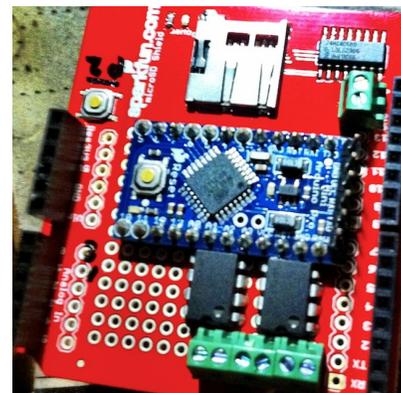
Update from Daniel Collins

Issue #13 featured an article from the skipper of *Alethia* about his Arduino-based solar charge monitoring system, and he sent a follow-up note along with these photos. He plans to add a 3.3V linear regulator to step down the +5V for the SD card, and will add an opto-isolator chip for the NMEA RS-422 port. When this is done, it will have the one NMEA port, two RS-485 ports, the SD card for logging, and a regulator that lets it run off ship power. He has also



hijacked the original RESET button on the Arduino shield to put the SD card into "eject mode," allowing him to safely remove it while the unit continues to monitor the network.

He is currently working on vessel repowering, pulling the smelly diesel (and its tanks) and replacing it all with an electric motor and battery bank. More and more, I am wanting to do this... investigation is continuing, and being in touch with others doing similar projects is highly motivating.



DEVELOPMENT FACILITIES



The image above is rather surreal to me... it's the house I lived in for 13 years, now empty. I landed on Camano Island in 1998, thinking it a short layover to build the Microship, and then, well, life got in the way. Even though the new digs are rental spaces, I'm delighted to be living and working right next to the boat with only a few dozen steps between lab and project.

The new facilities are also shown here. At right, Kirsten is peering out from our verandah as I "play radio" with a Yaesu QRP rig and the Buddipole antenna raking the late-afternoon sky during a sunspot-induced band opening on September 24.

Below, you can see a portion of the new lab. After much hand-wringing, I relocated the parts bins and drawers from the mobile lab parked down the street, and the little white table corner visible in the lower left is actually part of a 4x8 surface that will be the mockup of the on-board lab desk. The lit ceiling at upper right is above my piano studio, and the door on the far wall opens to an additional inventory room. It's a good workspace, enough to get me through this project... the other building, still holding the *Polaris* trailer, will be used for the less tidy work (sawing, machining, etc).



Kirsten (above) has started the hydroponics operation that will migrate into a dedicated cabin aboard *Nomadness*... much more on that project as it unfolds! It feels good to be starting seedlings in November.

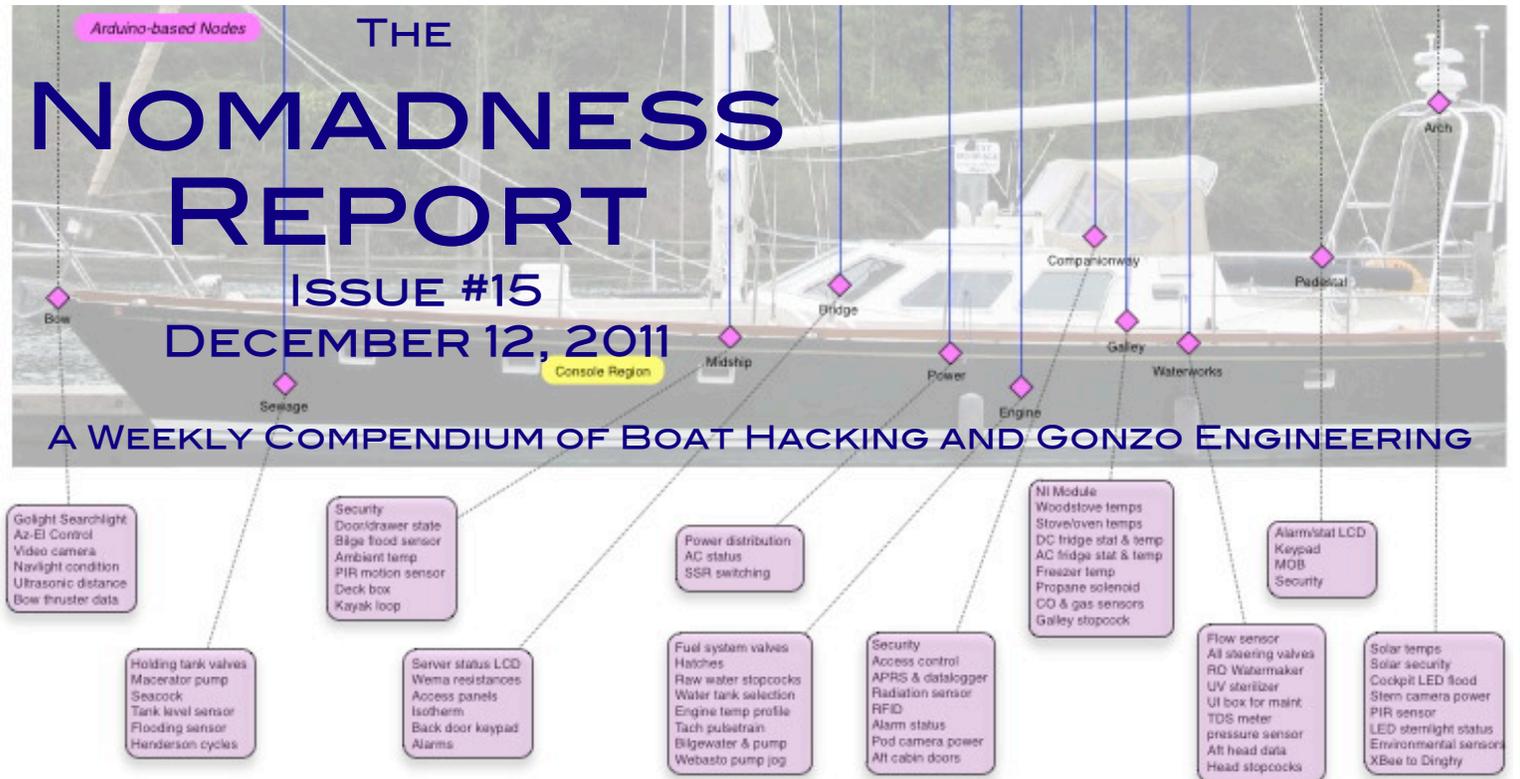
Isabelle has adapted to all this with aplomb, and now entertains passing tourists while patrolling the strip of land between lab and boat. Our team is in place, and the project is underway!



THE NOMADNESS REPORT

ISSUE #15
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A WEEKLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



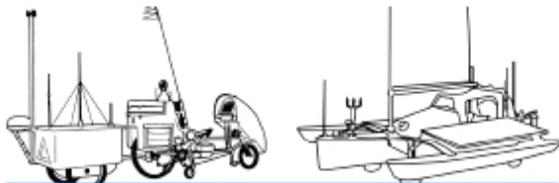
CONJURING THE CONSOLE

This is the first issue produced on my new MacBook Air, and I can say without hesitation that this is the best computer I've even owned (or even seen). I'm still incrementally moving in, since the creaky predecessor contains 2 decades of cruft from multiple wholesale migrations over the years and I'm ready for a clean slate. But yikes... a quarter of a terabyte with no hard drive? 1.7 GHz processor? For an old geek who started his technomadic career with the Kyocera paleo-laptop (known in the US as the Radio Shack Model 100), this is simply astonishing.

Anyway, this issue is focused on the emerging design of the ship's console. That little bicycle-console photo at the right is a hint of things to come; a meta-specification of this project is a diverse technological toolset, integrated into a single workspace with minimal overhead and maximal interconnectivity. This allows all sorts of entertaining applications to be created much later in the game, since the system lies inside a Busy Box of gizmology and I/O devices with normalized interface hooks.

The first step in all this is to build the box, shaped by the constraints of the substrate.

-- Steve



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The photo above is the console of my Winnebiko II bicycle, circa 1987... appropriate imagery now as I do the same thing to an 18-ton sailboat. Some things never change.

THE CONSOLE ENVIRONMENT



Here is the blank slate... the former salon of *Nomadness* that is going to turn into a lab with a wrap-around console consisting of five rackspaces, retractable magnetic desktop, pull-out piano, tool storage, audio & video production, ham shack, R&D facility, and Zone of Geekery. From the nerdy perspective, this will be the heart of the boat... though of course it has a few "hearts" in other domains as well.

The ugly plywood tabletop in the photo is a temporary fixture to aid in visualization and support the mockup console enclosures. I'm holding a tape measure extended to 21" (overall 24" if you include the body) - this is the approximate height of each rackspace, and is located about where the left edge of the communications bay will be located.

Technically, I could go all the way to the overhead with these panels, but that would introduce an impossible serviceability problem. Even if their innards could handily

hinge open relative to the cabinets (which was my assumption when I started this project), there would be no way to get to the backside of all this... nor to effectively use any surfaces other than the front one for hardware mounting.

I see no reason to constrain myself to classic rack construction, where all the hardware is mounted to units screwed to front and rear rails (with each "U" of height equal to 1.75 inches). Like *BEHEMOTH*, this will unfold in a variety of ways, providing about 10 square feet of mounting surface in each of the consoles as well as allowing access to the hull side, cabling, that opening portlight that will have to be replaced someday due to galvanic issues, and so on.

The front bottom edge of each console rack will be hinged to the mounting surface, and the rear will have a strong remote-release latch... allowing one module at a time to be laid on its face and then have its top, back, and partial side panels open to expose the innards.

Cables will emerge from the sides, with slack loops in the triangular regions between them and some "fingers" along the back to keep local tangles and long-lines to the ship under control.

In the photo above, those little wings on either side of me will retract under their respective consoles; the desk on which I'm leaning will likewise disappear under the consoles in front of me. This further enhances serviceability while also allowing a cozy little love seat for watching that TV on the starboard side or just chilling.

I haven't decided yet about sloping the consoles... it's unmistakably nicer to look at, but introduces additional complexity. We'll see. Given the need to surround each front panel surface with a gasketed rim for a protective door (affecting the hinge point), simply tipping rectangular racks back a few degrees might be enough to soften the look without making the fabrication project any harder than it already is.

COMMERCIAL RACK CHOICES

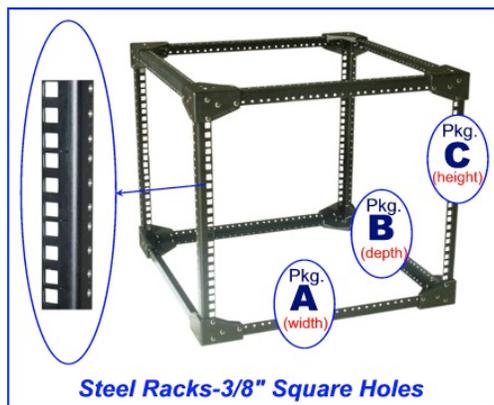
Naturally, a primary objective of this project is to avoid the Three Deadly Perils of Engineering: wheel-reinvention, epic learning curves, and spending too much money. My natural inclination is to find something off-the-shelf and adapt it, so the initial quest for the five racks kept me busy a-Googling for days on end.

With a target size of 12-14U (21 to 24.5 inches) and very little extra space for such niceties as suspension or exterior cabinetry, I quickly gave up on the tempting [SKB cases](#) used by bands along with some of the sexy music-studio packages that look like furniture. We get down to the skeleton quickly, and the three shown here are the standout choices.

The top one held me for a while... [Star Case](#) has a huge range of kits in aluminum and steel, and the latter can have either 10-32 threaded holes (fragile threads) or the more modern square-hole system that uses replaceable cage nuts. I used to package my homebrew computer systems and comm gear in surplus racks, and thread damage is a real hazard... doubtless much worse in the dynamic corrosive environment of a sailboat.

Unfortunately, the feature that makes the Star Case ones so flexible is also their undoing in my particular application... those corner braces eat 1.5" at both top and bottom of the enclosure. While they have attractive filler panels to prevent this from being an aesthetic issue, it adds up to a vertical foot of lost space in my case.

The one in the middle of the page, appropriately enough, is from [Middle Atlantic](#) - one of the big games in town, with a large and well-respected product line. I'd buy from these guys without hesitation, but unless I'm mistaken, the only option in the size range I need comes with pre-threaded 10-32 rack rails.



Still, I don't want to rule them out... but replaceable mounting hardware (in stainless) is an inflexible requirement.

The third image shows one from the old-timers in this business: [Hammond](#). They have been around longer than I have, and back in my consulting days I used their NMEA 12 enclosures for machines that had to keep working in the harshest industrial environments. I haven't seen their recent stuff, but this 1459 series looks interesting... and dimensionally it gives me 13U of height (22.75") with a minimal overall overhead:

- * Width 21.12"
- * Height 24.7"
- * Depth 16.14"
- * Load 800 pounds

This may be workable, though it's tight... the key dimension is the "hypotenuse" from bottom front to top rear, given the need to hinge forward without colliding with the overhead. Running the trig, I get 29.51 inches, which is right there at the observed 29.5 from swinging the tape measure around. Cutting it close.

The other dimensional issue involves knob clearance. Unlike some sexier rack products that recess the rails well inside an outer smooth envelope, everything mounted in the ones shown here is highly exposed. Laying it on its face is going to break something, so I'll need to build out a frame with a gasketed surface that allows dogging down a protective, removable door (for harsh conditions when the spray flies, a more comfortable backrest in love-seat mode, and times when I don't want fancy electronics to be quite so visible). This screws up that tidy hypotenuse calculation, so the choice is by no means clear... I need to see what dimensions can be nudged without doing something catastrophic like eliminating knee clearance or requiring a complex sliding mechanism to allow folding.

THE HOMEBREW RACK OPTION

While agonizing over all these issues, I started thinking again about the design assumption that launched this project: fabricating a wood cabinet with multiple open bays, bolting in commercial rack rails, and developing a hinging drawer-slide system to allow the whole assembly to fold down and then pull out for service. The problem with that, and the reason for looking at a more modular approach, is that the cabinetry (however beautiful) would make it almost impossible to get behind the structure. It would also have to be fabricated in place, versus the much more appealing idea of conjuring individual modules in the lab, then hauling them aboard when the time comes to do system integration.

I should also note that an important design objective is the ability to *remove* all this without either destroying it or requiring massive re-design to integrate it into another environment (on land or sea). Not only will I hopefully still want my toys handy when I'm 90 and not sailing quite so much <cough>, but when the time comes to sell this boat, the typical buyer is probably not interested in signing up for the immersive year of technical training necessary to deal with the systems that replaced a perfectly good dinette! It reminds me of selling my house in Ohio... one couple walked in the front door behind their realtor, and while the guy's face lit up, the woman wrinkled her nose at the machines and asked, "where's the living room?"

So modularity is critical, though of course that doesn't imply that it can't also be beautiful. Those utilitarian cages, covered over with panels bristling with knobs and blinkies, still need to be integrated into a warm wooden setting that goes well with the rest of the boat. Wouldn't it be sweet if the rack frames themselves were designed to play nice with all this, optimized perfectly to the shape of the available space and offering integrated access panels and the

aforementioned protective framing around the delicate panel faces?

While tromping around the web on a quest for more options, I stumbled across an interesting ebook on [homebrew rack fabrication](#) (1.5 MB PDF). The third of his designs (starting on page 6, with lots of photos) is an assemblage of common 1" square steel tubing, welded with a low-cost wire-feed MIG rig like the [Hobart Handler 140](#) that has been sitting in my Amazon wish list for the past year. It may be time to move it to the shopping cart... heck, I have a steel boat, right?

Ahem.



Anyway, I don't underestimate the learning-curve investment that would be involved with this, but I'm intrigued by the ability to create the precise structure that I need (still with industry-standard rails bolted on). Many of the "desktop" racks made by commercial vendors assume lightweight applications; when we start to imagine the entire mess going negative-G for a moment and then smashing into a wave trough, suddenly the idea of a lot of additional steel sounds very appealing.

I wouldn't call this a firm design decision yet; if the Hoffman units on the previous page can get me there, I'm not going to take on a welding project. And that leads to the all-important next step...

Console Mockup

The project that is going to get underway just as soon as I finish this long-overdue issue of the *Nomadness Report* is an actual-size model of the whole system, complete with hinging consoles, opening access panels, tool drawers, retractable tabletop, and the stealth piano that disappears into its sealed nacelle when not in use.

I usually do such things with scrounged corrugated cardboard along with duct tape and hot glue, but this project is just too big (and pretty) for that to be satisfying. So the next step up is a sort of high-tech cardboard that is used widely for signage... [corrugated plastic](#) (the most famous brand of which is [Coroplast](#)). I bought three 4X8 sheets of one of the alternative brands for \$15 each at a local sign shop, along with thirteen 8-foot 1x2 sticks of Douglas Fir to provide the framing structure. Bonding will be done with tape, pneumatic stapler, and urethane adhesives... and the frames will be assembled with the wondrous [Kreg Junior](#) "pocket hole joinery" kit. (If you ever have to stick wood together, this is the hot ticket; even serious woodworking guys, which I'm not, swear by these things.)

Hopefully, the next issue will have photos of convincing white boxes configured as a wrap-around console atop that temporary desktop, with printouts of front panels tacked where I think they should go. I suspect I'll be spending quite a lot of time parked in that space, playing *let's pretend* and gradually fine-tuning the ergonomics, serviceability, and panel configuration. I will leave all that in place on the boat as the real thing is assembled on the central work table in the lab, providing a reality check that informs the development process. Such things can easily drift out of synch with reality, driven by *creeping featuritis* and space distortion, so this process should keep us on track until the whole mess is moved aboard.

CONSOLE ZONES

So... after all this talk about racks and serviceability and cabling... what's actually going in to this wrap-around übergeek command center? I had hoped to have an OmniGraffle drawing of the panel layouts done by now, but that will have to wait for next time. Instead, let's start with a big picture of the five console zones, then indulge in a photo gallery of front-panel goodness.

Please visualize a top view of the space in the opening photo, with five big boxes arrayed around me, their edges touching at 45° angles. These are about 21 inches wide and 16 inches deep, and may or may not be tilted back a few degrees to improve ergonomics. From this description, you can see that there are console faces directly to my left and right, one dead ahead, and two angled ones connecting the former to the latter. They are designated by letter, and here's a quick summary of their gross functionality:

A - Network

This one (located closest to the pilothouse, to my left in the photo on the opening page), contains most of the computing geekery. There's a Sonnet rackmount tray that can hold two Mac Minis (one of which will be on all the time and runs the ship), a RAID disk array of 4 TB or so, and a big panel-mounted LCD that takes up most of the rackspace... independent of another mounted on a swing-arm and useful to the piloting and nav stations as well as the lab. A custom panel, probably 3U (3 rack units, or 5.25 inches) contains all the random gadgetry: indicators for the router and other networky stuff, a couple of small LCDs for local Arduino nodes including the mega-crossbar, security controls, status and diagnostic LEDs, and maybe a Chumby display as a back-channel Internet appliance that does not require Big Iron.

B - Media

The second console, angled to my left, is topped by a Crown Mode D power amplifier, below which are two custom panels. The top one carries a dedicated video monitor, Fusion marine stereo with iPod dock, speaker switching, the iControl for GarageBand (maybe... this is cool but non-essential and can yield to more important items if needed), and some experimental audio hardware. The bottom one has the Edirol M-16DX mixer panel (with the connector box located behind the panel), Tascam DP-008 multichannel recorder, and some convenient audio I/O connectors. The angled location of this console off to the side should coexist nicely with the digital piano when it's pulled out in lieu of the tabletop.

C - Communications

Directly in front of me when seated is the radio shack... Icom M802 SSB rig with speaker (thus not requiring system audio routing tools -to be working), M604 marine VHF with remote mics at both inside and outside helm stations, Icom 706mkIIg ham rig

(redundant, but with a very different operating character from the 802), Kenwood D710 digital dual-bander with APRS, Icom AIS unit, PACTOR TNC, antenna analyzer, Wavenode Power/SWR display with four remote probes, Furuno NAVTEX receiver, dedicated GPS independent of the primary nav unit, WWV-synchronized clock, and a cluster of random controls. There are also connectors for things like headphones, microphones, CW key, and so on... all independent of the relatively power-hungry system audio routing tools for maximum reliability.

D - Lab

Angled off to the right is the cluster of R&D tools along with a few stray items that would introduce clutter in the other consoles (like a coax patch panel for rerouting antennas, AC outlet strip, ethernet ports, NMEA 2000 drop, and a local breaker panel serving this and neighboring consoles... downstream of one fat breaker over behind the main power panel in the pilothouse. This region also houses the test equipment: digital storage oscilloscope (probably the new Owon SDS series, since they are quiet and can run on battery), bench-type DMM, soldering and hot-air station (one less thing to drag out and plug in, though I of course have a portable also), bench power supplies, and random I/O and shipnet connectors related to Arduino node development.

E - Tools

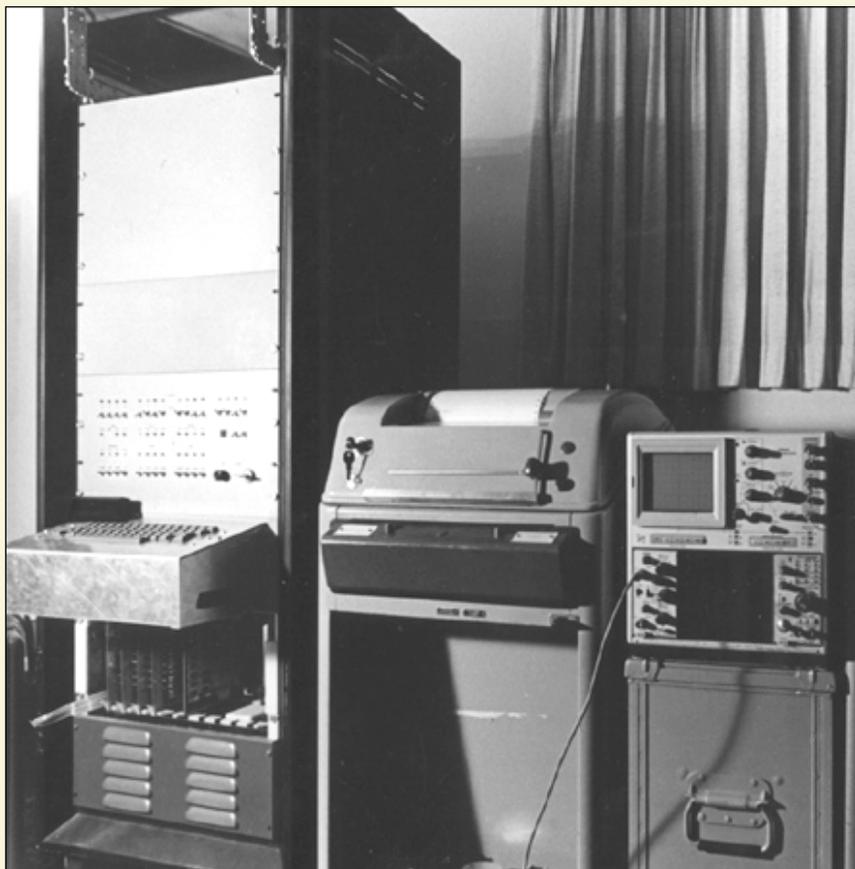
Finally, on my right, is a tool cabinet. I'm indebted to "DWM" on the excellent [Garage Journal](#) forum for suggesting that I just use off-the-shelf rack drawers in an identical rackspace instead of trying to find a tolerable flip-top tool cabinet that would be of adequate quality. This translates into six locking drawers (probably five 2U and one 3U), taking care of all my tool storage needs much more conveniently than my current mess of [roll-ups and kits](#) (link to a page on my site; see top photo) crammed into a large wooden drawer underneath the seating platform. This is enough of a nuisance that I almost never put my tools away; having an integrated cabinet at the primary workspace, along with a bench-top that disappears every time I want to play the piano, should cure that habit.

Speaking of tools, there's a related category that doesn't fit here but is equally critical: bulky power tools. These will be in dedicated bags attached to labeled and tethered lines, slid into the long and otherwise completely useless bin that extends behind the TV all the way to the bulkhead.

The other two "tools" of note are the central shop vacuum and air compressor, both of which will be under the original seats below the console. I haven't yet decided if I'm acquiring that welder, but if so, I'll probably end up hauling it as well... stashed into the same general area.

OK, let's look at some pretty pictures!

RACK SYSTEMS OF YESTERYEAR



Just for a quick contextual non-sequitur, if that makes any sense, these are the three rack environments from my checkered past. The one above was my room in Air Force tech school dorm in 1971, dominated by my beloved Hammarlund SP-600 shortwave receiver. I haven't met a solid-state rig yet that feels as sweet.

On the upper left, you can see my original homebrew 8008 system, circa 1974. The machine is now in the Computer History Museum (along with my bike) and this photo was taken in my Louisville apartment. That 6-foot rack was from an Idaho surplus outlet, and I loved it... but it was nothing compared to the beauty at lower left.



This dual console rack had sloped upper and vertical lower sections, rear doors, and a pull-out desktop. I think this inspired my current design for the boat, and it's on my list of Things I Regret Selling (along with a '59 Bugeye Sprite, a Victorian house in Louisville, and that Hammarlund rig). This photo was taken in 1978 during a shoot for a Byte magazine article about my [polyphonic music keyboard](#) design.

CONSOLE GIZMOLOGY SAMPLER

There will be lots of detail in upcoming issues about the layout of console panels; there is a mega-drawing in progress that has all the devices to scale, with properly sized rack units that detent into place with graphic fills that show actual front panel layouts. When that's done, I'll paste a hardcopy on the mockup and wrap a special issue around it.

For now, I'm going to content myself with a teaser... lots of little photos of actual devices that will be part of this. Conspicuously absent are the custom panels that contain the miscellany of homebrew user interfaces... but this will give you an idea of the scope of this console project.

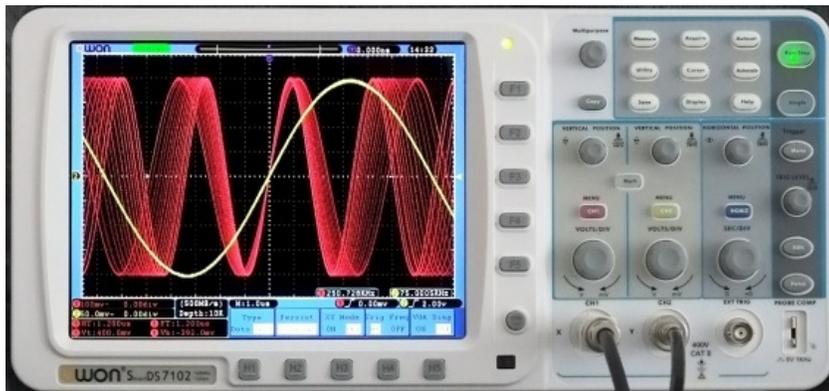
Please note that I have made no effort to scale these images



correctly relative to each other. Most were lifted shamelessly from the web, but are the real items accumulating here for integration into the lab/studio rack space.

This is why the console needs well-sealed doors... one splash of salt water and I will be VERY depressed.

Enjoy the sneak preview!



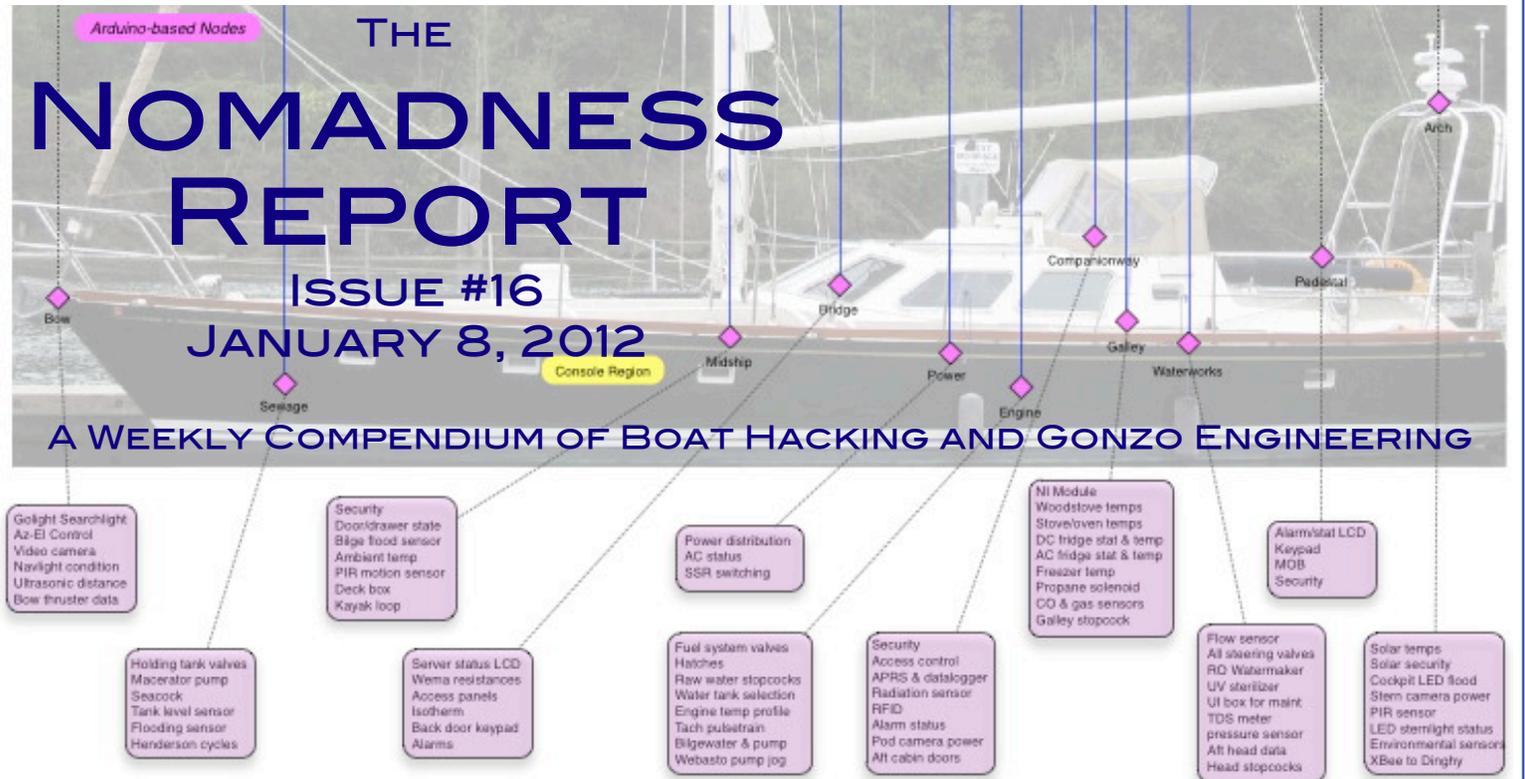
CONSOLE GIZMOLOGY SAMPLER



THE NOMADNESS REPORT

ISSUE #16
JANUARY 8, 2012

A WEEKLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



HYBRIDIZATION ANALYSIS

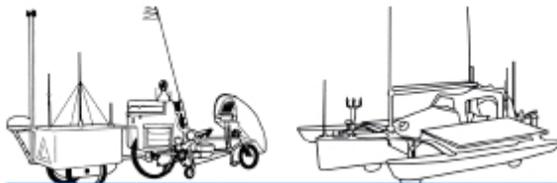
Hello! This issue reports on a significant transition in the project... we have just committed to a departure deadline.

That is no minor matter, for without a clear objective it is easy and natural to coast along, immersed in projects that flourish in the rich protein stew of technology. I'm not talking about mere *creeping featuritis*, a limited "product development" version of this phenomenon; I'm talking about an obsessive quest that can never be fully satisfied... a quest that evolves endlessly, always a step or two ahead of available tools, shaped by the stuff of dreams and unfettered by the constraints of deliverables.

I have lingered there for years, but if I'm not careful, entropy will claim me long before I can again reach escape velocity. To forestall the grim eventuality of spending a lifetime spent linearly chasing exponential dreams, I have just nailed an event to the calendar... very publicly.

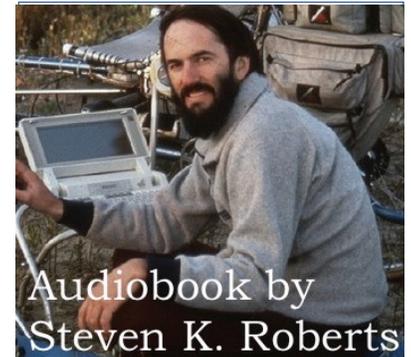
In 205 days, we will cast off our docklines and head north. The reshuffling of the TO-DO list was so energetic that I could *hear* it, echoing through filesystems and bouncing off of whiteboards. A lot has changed, but we're more on track than ever.

-- Steve



Nomadic Research Labs

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Audiobook by
Steven K. Roberts

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This publication is available as a weekly PDF for \$20/year... or quarterly eBooks. The price of the electronic version is low (only 38¢ a copy!) to encourage subscribing. Please visit the [Nomadness Report](#) page on our website to sign up, or the [Store](#) for back issues.

The photo above is the cover of my audiobook of Computing Across America, being published free on my website. [The first chapter](#) is now online.

CIRCUMNAVIGATION COUNTDOWN



projects. We even have a countdown clock on the *Nomadness* website, inexorably ticking away...

My first act upon establishing a firm plan was to restructure the sprawling multimedia to-do list spanning boards white, black, and cork (as well as a few software tools). Clustered logical groupings of projects that parallel system architecture are no longer meaningful with a near-term deadline, so I created an online list of the things that [have to happen before departure](#). Phew! The clarity is dizzying!

That document is tweaked throughout the day, and when items are done, they are lined out but left in place for context. As projects drop away, they are deleted. There are three related documents (Long-range, Other, and Shacktopus) as well as an introductory page... all under **Projects** at the right end of the menu bar.

It's as if everything here has kicked into high gear, and the energy is palpable. I am hoping to parallel this with a return to the weekly schedule of this publication, now that actual work is getting done.

The Technomadic Flotilla

The other immediate effect of this burst of clarity was a resurgence of a long-savored fantasy... traveling as a loosely linked community of boats. People come from all over the world to sail waters that are just outside our back door... this region is crawling with sailors who see this loop, as do I, as a sort of *Holy Grail* of Pacific Northwest cruising.

I set up a "Secret" Facebook group for voyage planning, and have begun inviting friends with boats to join us for a 2-month adventure. Readers of the *Nomadness Report* include a number of kindred spirits, so if this catches your eye... please get in touch! At this point, we have just begun the discussion, so there's plenty of opportunity to participate in early planning.

We are not racers, and we have plenty of respect for summer gales that can funnel through Johnstone Strait (as well as the complete change of conditions that begins when you round Cape Scott at the north end). A *sailor with no schedule always has fair winds*, so we'll layover as needed to avoid a bashing death march or too many white knuckles.

Being geeks, of course, I think it's inevitable that our little flotilla will be equipped with APRS, an ad-hoc LAN, and other tools to give us a sense of community and awareness of everyone's location.

I sampled this sort of thing once (sans the tech), single-handing my Corsair 36 trimaran to Desolation Sound in the company of 6 other multihulls. It was, in a word, awesome.

So, please consider this your invitation to explore the possibility of a nautical adventure this summer!

Over three decades of geek adventures, I've found that having a public deadline goes a long way toward lighting a fire under the to-do list. For the past three years, *Nomadness* has been way too idle, and even after moving into "optimum-enough" workspace, there was still a habitual sense of languor... as if I have all the time in the world.

Well, I don't. None of us do.

About a week ago, an interesting thing happened here at Nomadic Research Labs. Kirsten and I felt a distinct click, and she suddenly experienced the transition into a personal investment in the project. This may sound strange after being together full-time for over a year, but I understand: imagine walking into a life with decades of project continuity, a big boat, a few exes, a hugely intimidating list of projects, and a public persona that includes all of the above... in detail. It's a lot to take on, and easy to feel like stepping awkwardly into someone else's shoes.

The first effect of this epiphany was that we began talking immediate plans, not the long-range global objectives that define the big picture. What is going to happen THIS year?

The maplet above shows the answer. On August 1, we'll launch north from our La Conner facilities and begin a relaxed 2-month circumnavigation of Vancouver Island... with a side trip to Princess Louisa Inlet. The objective is realistic, yet challenging enough to require attention and good planning. Small local jaunts earlier in the season will serve as shakedown, so we and our boat should be reasonably ready.

Kirsten has been diving into the books (notably [The Voyager's Handbook](#) by Beth Leonard, as well as cruising guides to the region), and participating in hands-on



HYBRIDIZING NOMADNESS?

As I mentioned in Issue 13, one of my enduring fantasies for this ship is to modernize the propulsion system... trading a big ol' diesel auxiliary with a genset on the side for an electric motor with Lithium-ion battery bank, smart controller, and newfangled diesel generator optimized to play nice in a propulsion role.

This is a sane way to do things, eliminating diesel abuse by using the battery for short-duration motoring needs: keeping bow to wind while hoisting or dousing sail, getting out of the channel, maneuvering in the harbor, scooting free of a collision course, station-keeping to deal with a crew overboard, and so on. And as long as the generator is suitably scaled, there is still a way to reliably cruise using the much deeper energy inventory of fuel tanks (in my case, about 240 gallons, or roughly 1700 miles of motoring range).

I have been in discussions with [Annapolis Hybrid Marine](#), which is the US rep for [ASMO](#), a Danish maker of motors and controllers for hybrid marine propulsion. There is potential for a win-win relationship here, given my data collection and monitoring systems as well as ongoing publicity, and we have gotten past initial discussions and begun the nitty-gritty analysis to determine if this is a realistic solution for *Nomadness*.

The rest of this article is based on information provided by Sally Reuther, CEO of the Annapolis company. Armed with specs on my boat and a few design tools, she provided the following feasibility study, then I edited for the sake of this narrative.

Nomadness and Triton 22, by Sally Reuther

The calculations and graphs that follow show that a Triton 22 will do fine with your boat, and that you will be able to reach 6 knots (or a bit more depending on prop choice). We found during sea trials on a Hylas 44 that our calculations are pretty close in the lower range, but at higher speeds we are definitely erring on the cautious side which is good news indeed! Bill, the owner of the Hylas, has headed south with his boat and is quite pleased so far with what he is able to do with the system. He is running a bank of 72 volt, 210 amp-hour thin-plate AGM's and using his 5.5kW AC genset for charging when he can't get to a dock, or for lower speed motoring. We estimated 3.5 knots with that genset, but he has been getting over 4.

It is important to note that our current analysis program does not incorporate Peukert's formula to account for battery capacity losses at different charge rates, and thus assumes that every amp of recharge current becomes stored energy in the battery... when in reality, about 5% is lost as heat. We are working on a version that incorporates them, but the formulas are involved and David has not had time to work them into the spreadsheet.

Anyway, the drawings show four scenarios. I used a standard 96 volt, 210 amp hour battery bank and a 30% depth of discharge to run the calculations against.

Obviously when we get further into this we can talk about a redundant bank, or lithium, as well as wind and solar along with the genset. I know you already have a 7.5 KW genset onboard, but I decided to do the calculations with a 20kW PolarDC unit. That will give you the best ability to motor for extended periods if necessary.

☀ The **Day Sail** sheet is just that: leave the dock under power and motor for an hour to get out to open water. Then raise sail and spend the day sailing... then douse them and motor an hour back in. This is using battery only, with no generator.

☀ The **Motor 6 Hours** scenario shows motoring only for 6 straight hours at the best speed to achieve the furthest distance without depleting the battery bank more than 30%.

☀ The **Motor Sailing** scenario is based on some assumptions: no wind to begin (so you motor only with battery)... then the wind fills in so you turn on the genset to charge the batteries while you catch enough breeze to get you 4-5 knots... then you go back to motoring as the wind dies... then have another bit of motor sailing when the afternoon breeze fills in... and finally end the 9-hour day with motoring to an anchorage for the night.

☀ The **Motor Sailing 2** scenario is identical to the above, but the genset is on the entire time.

These are all theoretical numbers, but they give us a starting point from which we can build a system.

I ran the calculations for the best size diameter and pitch for your prop, and came up with a diameter of about 22" and a pitch around 16. We will work closely with Lars and his team at ASMO, along with a prop manufacturer, to get the best measurement for you on that. That size is based on slowing the rpm down so you can run the larger diameter prop and get 6 knots of motoring speed.

I don't remember if we talked about folding versus fixed 3-blade props. The choice has to do with whether you want to work on that elusive regeneration under sail which works best with the 3-blade fixed prop, or sail faster with a folding prop. Lots to consider there, and we can decide later what will make the most sense. What we may want to do is switch props at some point and have you collect data for each. One thing that is sadly missing in a lot of this data is testing with various types and sizes of propellers to see what actually works best with electric propulsion. We may be able to work with a prop manufacturer to let us use a selection of props for testing.

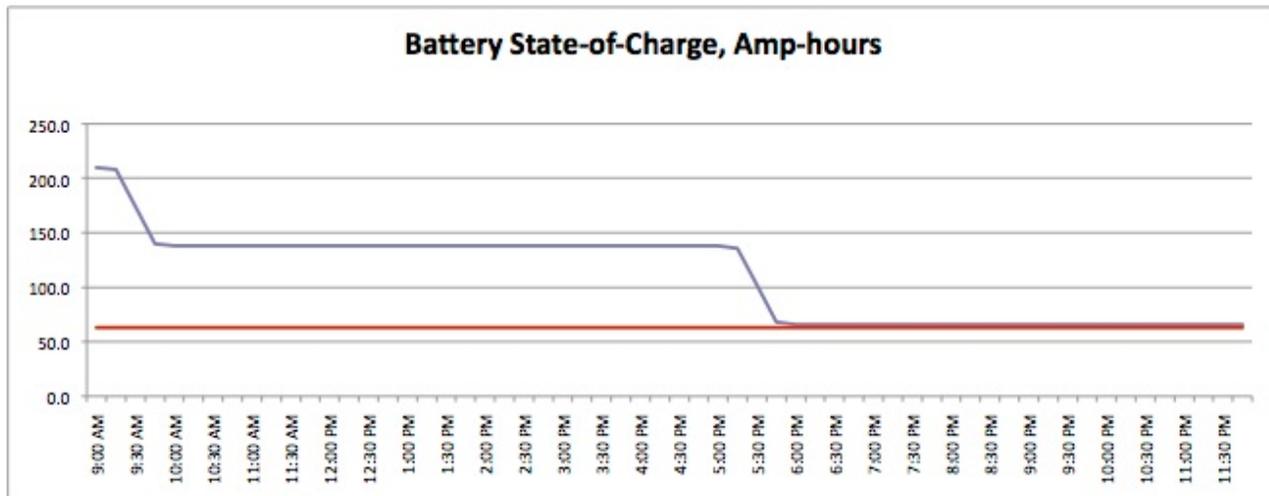
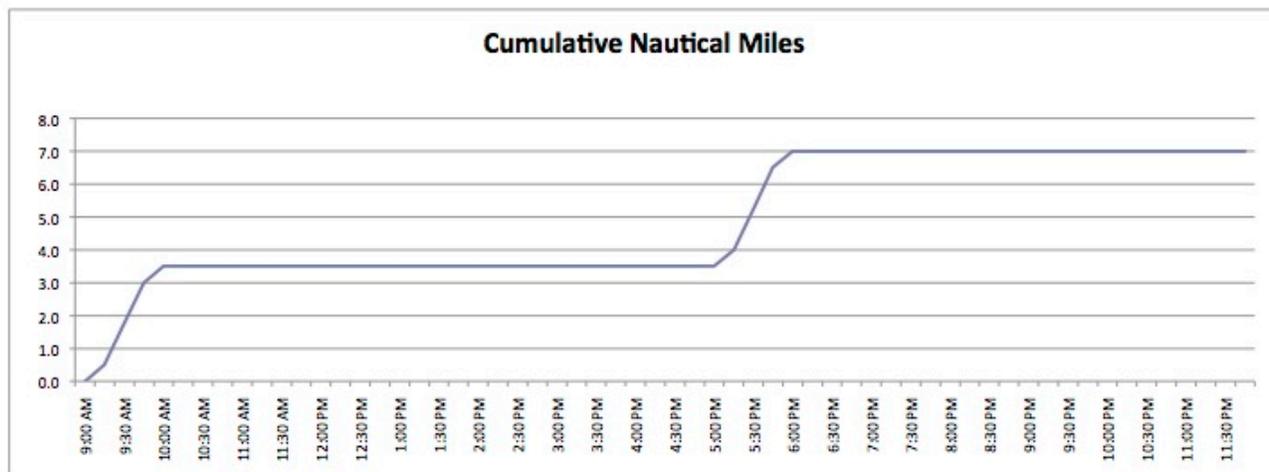
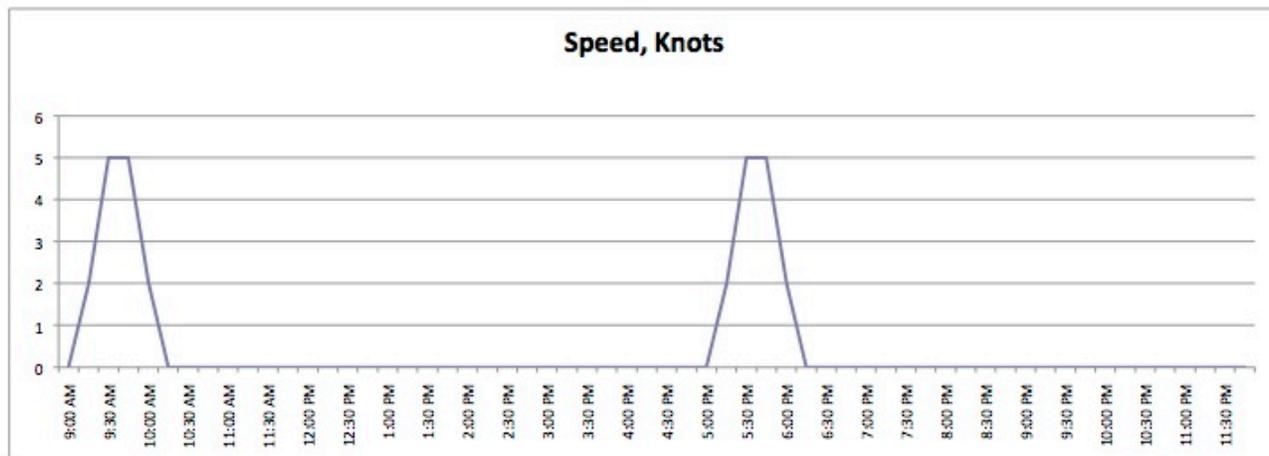
(The comments on the next 4 pages are by Steve.)

DAY SAILING PERFORMANCE

The spreadsheet that spawned these graphs shows *Nomadness* motoring from 0900-1000 and 1700-1800, starting at 2 knots, running up to 5, then back to 2. The assumption is that we're just using the motor to get out of the harbor for a day of sailing, then do the same to return to the slip. Total travel under power is 7 nautical miles, and minimum allowed battery capacity is 63 amp-

hours out of the 210 in the assumed bank. Peak current to the motor at 5 knots is 135.5 amps, corresponding to a 13 kW load.

This is the simplest scenario, and is realistic for normal recreational cruising... when there are no particular range objectives and little need to motor for any reason other than getting in and out of a harbor.

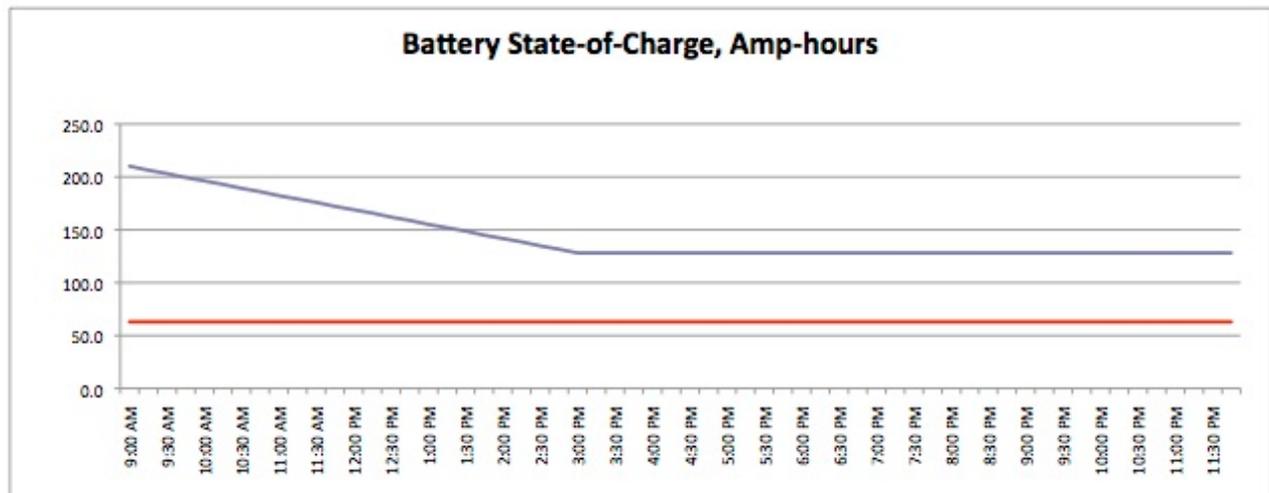
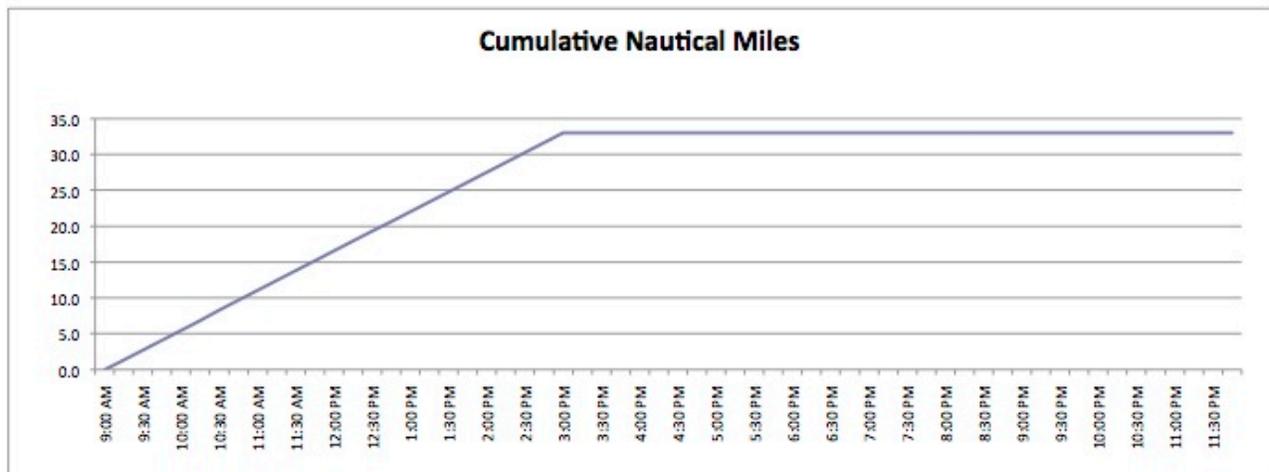
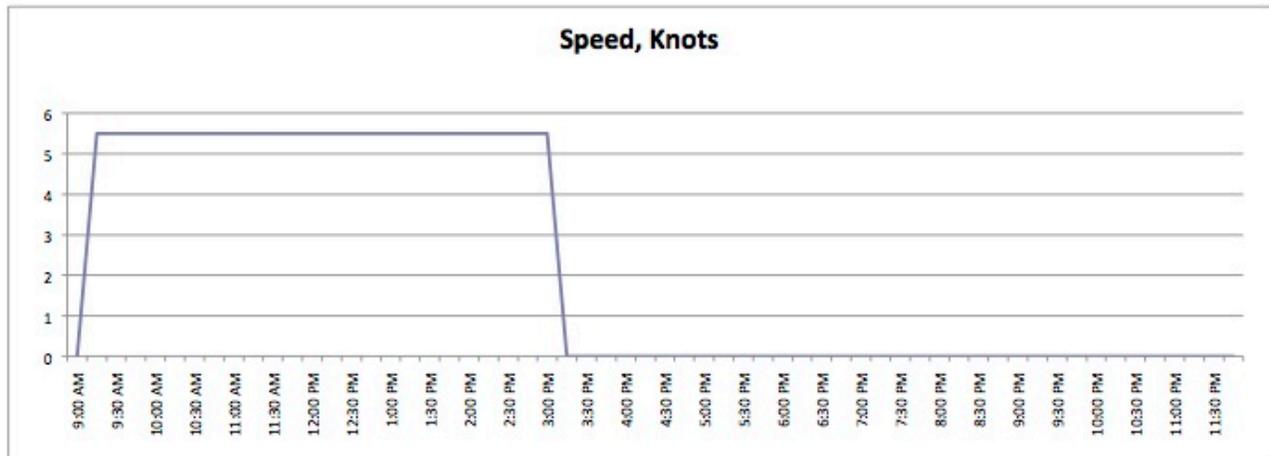


MOTOR 6 HOURS PERFORMANCE

Here, our objective is to find the most efficient speed at which to motor steadily for six hours without taking the 210 amp-hour battery bank below the 30% discharge (for AGM, you don't want to go more than halfway down or you shorten battery life severely... in this case, we are using less than a third of the bank's capacity and letting the generator do most of the work).

In the associated spreadsheet, we see a steady 5.5-knot speed from 0900 to 1500, for a total of 33 nautical miles. Motor draw is 17.3 kW, or 180.3 amps... with the generator is contributing 166.7 and the battery 13.6.

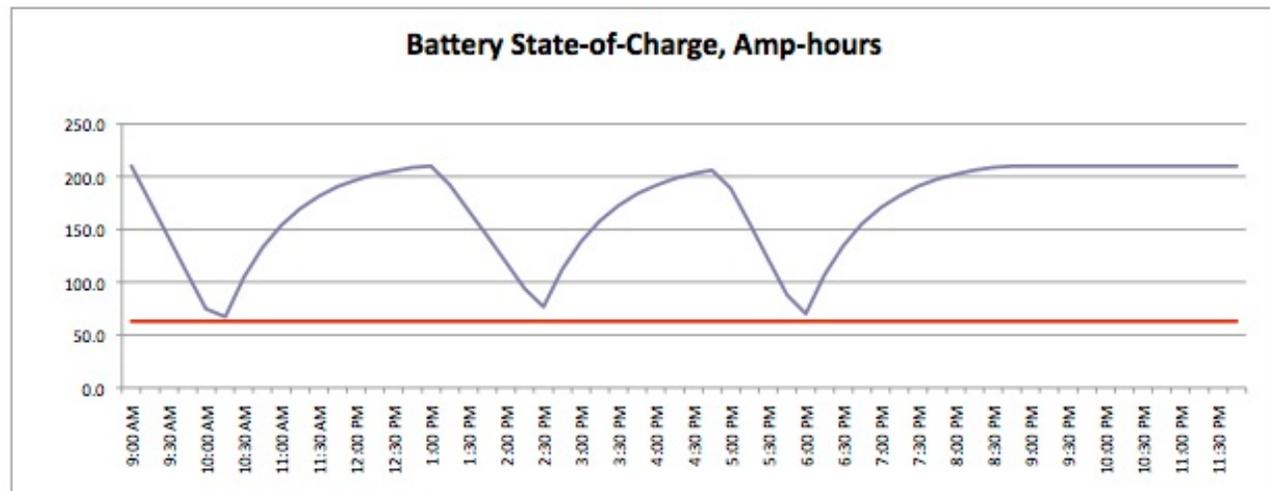
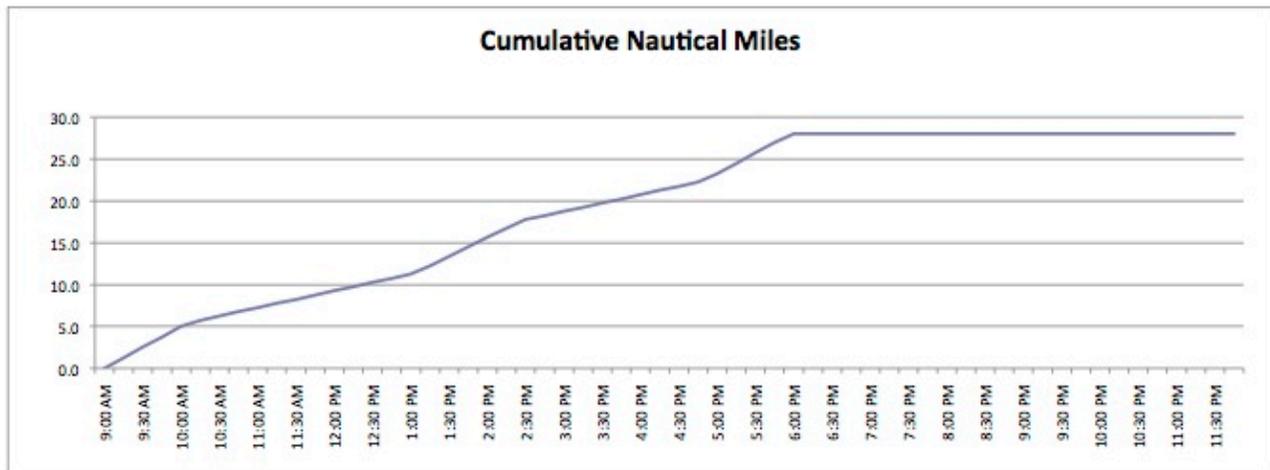
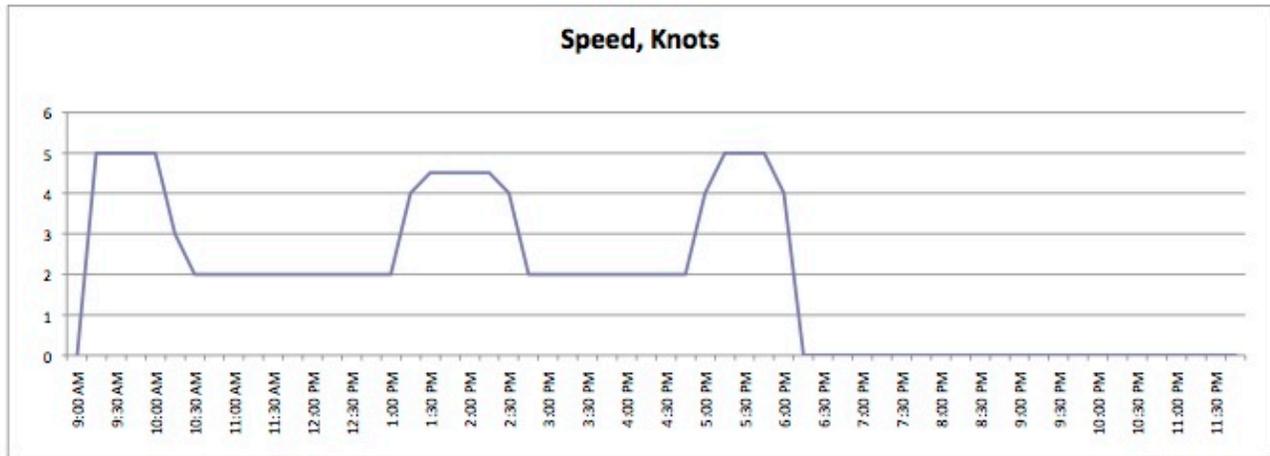
5.5 knots is a bit leisurely for *Nomadness*, and my intent will be to reliably cruise at 6.5-7 and "punch it" for more in emergencies.



MOTORSAILING PERFORMANCE

A more complex and realistic scenario is described in the article... a mix of motoring with battery power, sailing, and recharging with the generator. Motorsailing is a delight, synergizing two energy sources in a satisfying way, sometimes doing surprisingly nice things with apparent wind using only a modest amount of propulsion energy.

The input spreadsheet to this is complex, with heavy current draw only from 0900-1000 and 1700-1800... as well as a lesser power cost during the primary motorsailing window from 1300-1500. Again, this may be a smallish battery bank for the application, so it is very sensitive to the relatively short periods of operating on battery power.

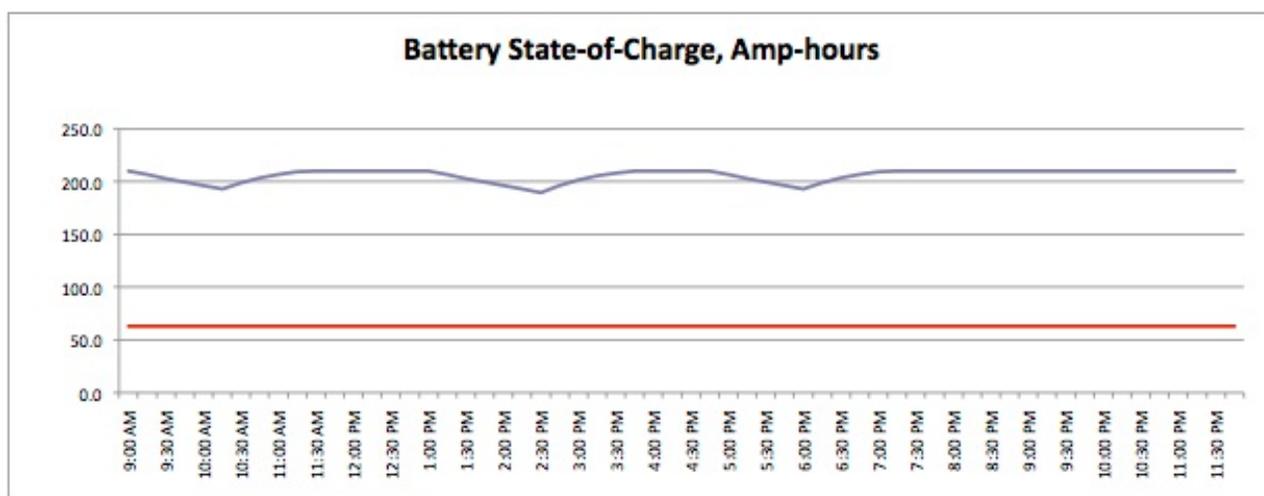
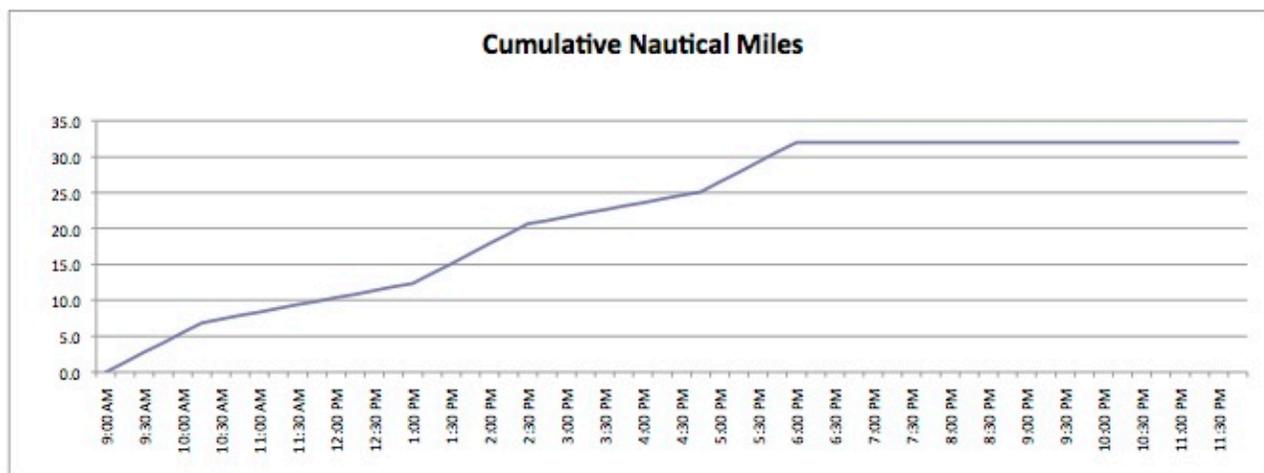
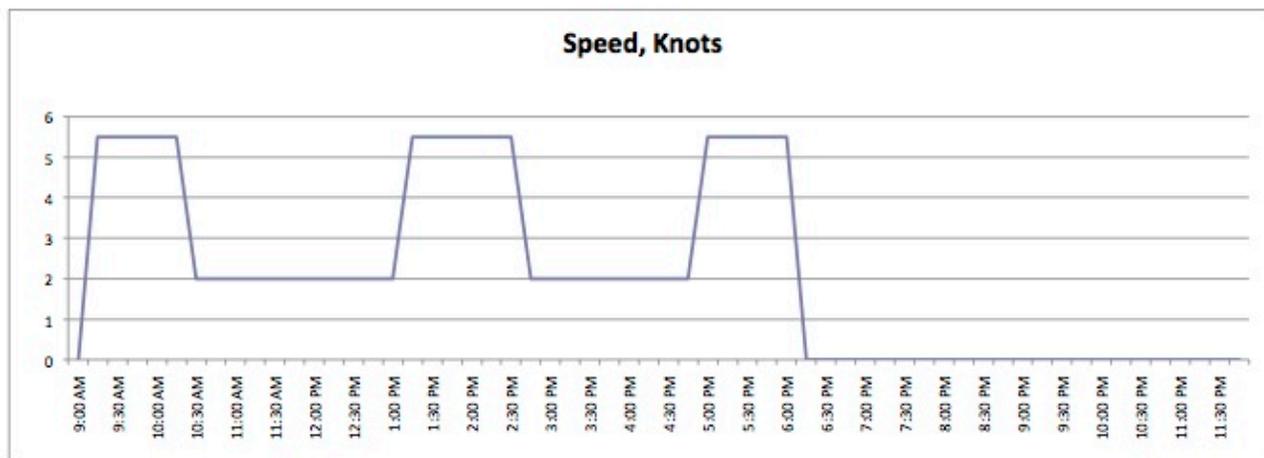


100% GENSET PERFORMANCE

Finally, we take the same scenario shown on the previous page, but change one thing: keep the generator running all the time. We travel a little further, and are continually charging the batteries.

Further calculations are needed to ensure that we can get closer to hull speed... but a significant investment may yield a robust and flexible system that can have greater reliability than the existing conventional auxiliary

(which is abused by short runs and offers no way to harvest energy from solar, shore power, wind, or the elusive regeneration under sail). These curves are a starting point for what could be a very intriguing project... and it's good to be working with folks in the industry who value the geekery I bring to the party. If we do this, it will be heavily instrumented, streaming real-time performance data... stay tuned!



HELM SEAT DESIGN

The hybrid analysis is exciting, but a project of that scale is not going to happen between now and departure for the Vancouver Island loop... so we'll just call that "research" for the moment. With the countdown clock nearing 200 days, what is happening NOW?

One of the first jobs is a helm seat. This sounds trivial, but I've spent far too many hours with a burning back, standing at the helm, vowing to deal with the problem one of these days. I've always assumed it would be a post and conventional marine seat, though a fellow steel-boat sailor in Oak Harbor fabbed his own. In the picture at right, the curvy top of the lazarette is too low to be useful as a seat (can't see), so I end up standing between it and the wheel.

We started looking at the problem the other day, performing inversions and other mental exercises to find a quick solution to this first of [many projects](#) that are being launched more or less in parallel. Since the curvy wood pieces have to hinge open to access the lazarette stowage (split at the center), and since easy access through the stern gate is necessary to use the dinghy, whatever we do has to be very flexible.

I suddenly remembered the exquisite "catbird seats" on my old Corsair 36 trimaran (below). These were *the* place to be while under sail... comfortable, great visibility, and only a tiller extension away from easy steering. Well. Why not do the same thing on this boat?

And, why not make it big enough for two, so Kirsten and I can perch comfortably side-by-side at the helm?

I've just ordered all the 7/8" rail fittings to fabricate a 4-foot mesh seat that hinges up to starboard. An extra



loop of rail on that side adds mounting space for things like handheld radio holsters, and the left side simply lands on the end of the wooden lazarette cover with a pair of crutch tips (bungeed down to keep it under control on port tack when we're steering from below).

The seat itself is recycled from a mesh trampoline made for the Microship, with additional spur grommets from [Sailrite](#) added to allow lacing in both axes. A padded backrest will velcro to the existing stern rails (hanging over those two gate segments that are dangling in the photo above).

Other major enhancements to the outside helm include an improved pedestal guard with a pod to carry the chartplotter and other local instruments, the Icom remote VHF microphone, and a few minor controls. The lazarette itself, under the wooden seat, is currently a cluttered mess; it's getting a segmented region with a pair of propane tanks. A shore tie reel is going on the stern (along with the [Sailomat](#) windvane), and a Dickinson marine barbecue will find an out-of-the-way spot near the Lifesling.

And now...

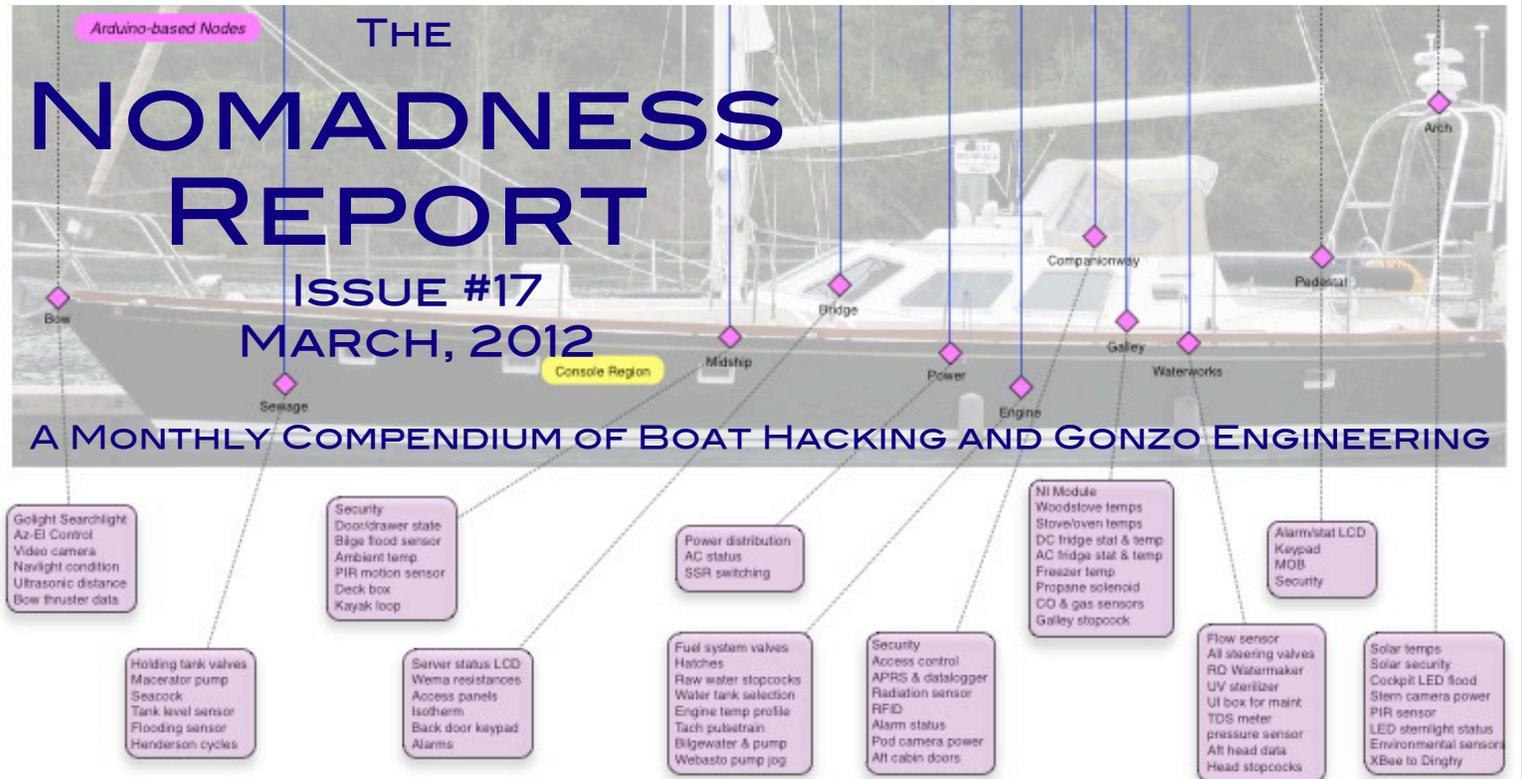
I know I've said this before, but publication of this report should ramp back up now. The difference is having a launch date, as well as the incredible buzz of energy that has resulted from the epiphany I shared at the beginning of this issue. Our intent is to blast through all this pragmatic stuff so we can have some proper time on water, then the nautical substrate will be ready for a focus on übergeekery.



THE NOMADNESS REPORT

ISSUE #17
MARCH, 2012

A MONTHLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



16 PAGES OF NAUTICAL GEEKERY!

Welcome to Issue #17, the first to be released on a more relaxed (and realistic) monthly schedule. The target publication date will be the first of each month, with the page count increased to compensate. The net effect should be much more substantial... more on the subject on page 16.

This issue features the shift in project focus introduced by the August departure around Vancouver Island, technical details on my AIS receiving station that streams local ship positions to servers around the world, the circuit-breaker database, on-board Mac Minis and wireless Internet access, a 29-year laptop contrast, a few maintenance notes, Microship availability for the Canadian adventure, new navigation tools and other Shipnet developments, a bit of marine networking history, update on the mesh helm seat, random comments various, and additional commentary on this publication.

The focus now is on helm consoles (both piloting and power), as well as a long-needed pedestal system at the outside helm for chartplotter, instrumentation, and communications. There's much fun ahead!

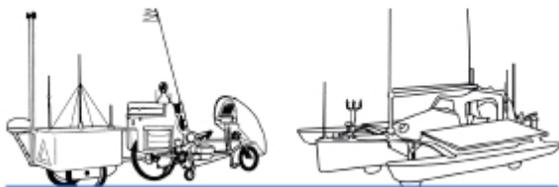
-- Steve



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This publication is available as a monthly PDF for \$20/year... along with eBooks & print editions. Please visit the [Nomadness Report](#) page on our website to subscribe with PayPal, Visa/MC, or check; back issues are available in the [online store](#).

The photo above is from an [article about BEHEMOTH](#) by Carl Zimmer in Discover Magazine, back in July of 1991. I was nearing the end of the Bikelab epoch...



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INFRASTRUCTURE VS GIZMOLOGY

The worst of the winter has given way to the long, dreary slog that seems it will never end; I remember many a May in the forest of Camano, bundled in a down coat and grumbling about life in the Pacific Northwest.

But it feels different now, with the countdown clock on the [Immediate Projects](#) page relentlessly reminding me of the difference between key infrastructure and the gizmological overlay. Vancouver Island circumnavigation less than 6 months away... was it only two months ago that I was laying out rackspaces for the on-board lab (and, typically, buying geek goodies to fit)?

This is good, though. The things that cause constant annoyance while aboard are the things that have to be done first... relatively boring stuff like power control, plumbing, navigation networking, cabin carpentooning, controlling the sails, staying warm, sleeping without pain, and keeping the engine running when needed. These categories may not be whizzy, but they are very broad... and the fact that it's *infrastructure* doesn't mean we can't have some fun with it!

Not only are some of these topics technologically insane on their own (like the absurd proprietary mess that is the emerging NMEA2000 marine networking standard), but they are the underpinnings of this whole system... so it behooves us to do it right and have fun with the process.

The ticking clock should keep me from straying too far into esoterica until after the Vancouver Island adventure. I expect to return from that with a (hopefully short) list of fixes, take care of anything remaining on the *Immediate* list, then focus attention without guilt to the sexy stuff: lab console fabrication, integrated piano, multimode ham shack, network of Arduino nodes, on-board server and its shoreside mirror, hydroponic garden, hybrid repower, redneck bow thruster, and lots more.

In the meantime, this photo—the only one I have from an external perspective of *Nomadness* under sail—is a good reminder of WHY. (Thanks [George and Celeste](#) for snapping this pic back in 2009!)



AIS RECEIVING STATION

One of the many hot new technologies in the nautical world is AIS - Automatic Identification System. There's a very good overview of it on [this Wikipedia Page](#). I've long enjoyed APRS (see Issue #10), so I'm naturally drawn to a tool that provides a live, radar-like display showing the positions of ships that are potential collision hazards.

AIS has been developing for many years, and has finally stabilized to the point where recreational mariners consider it an easy choice... with most of the

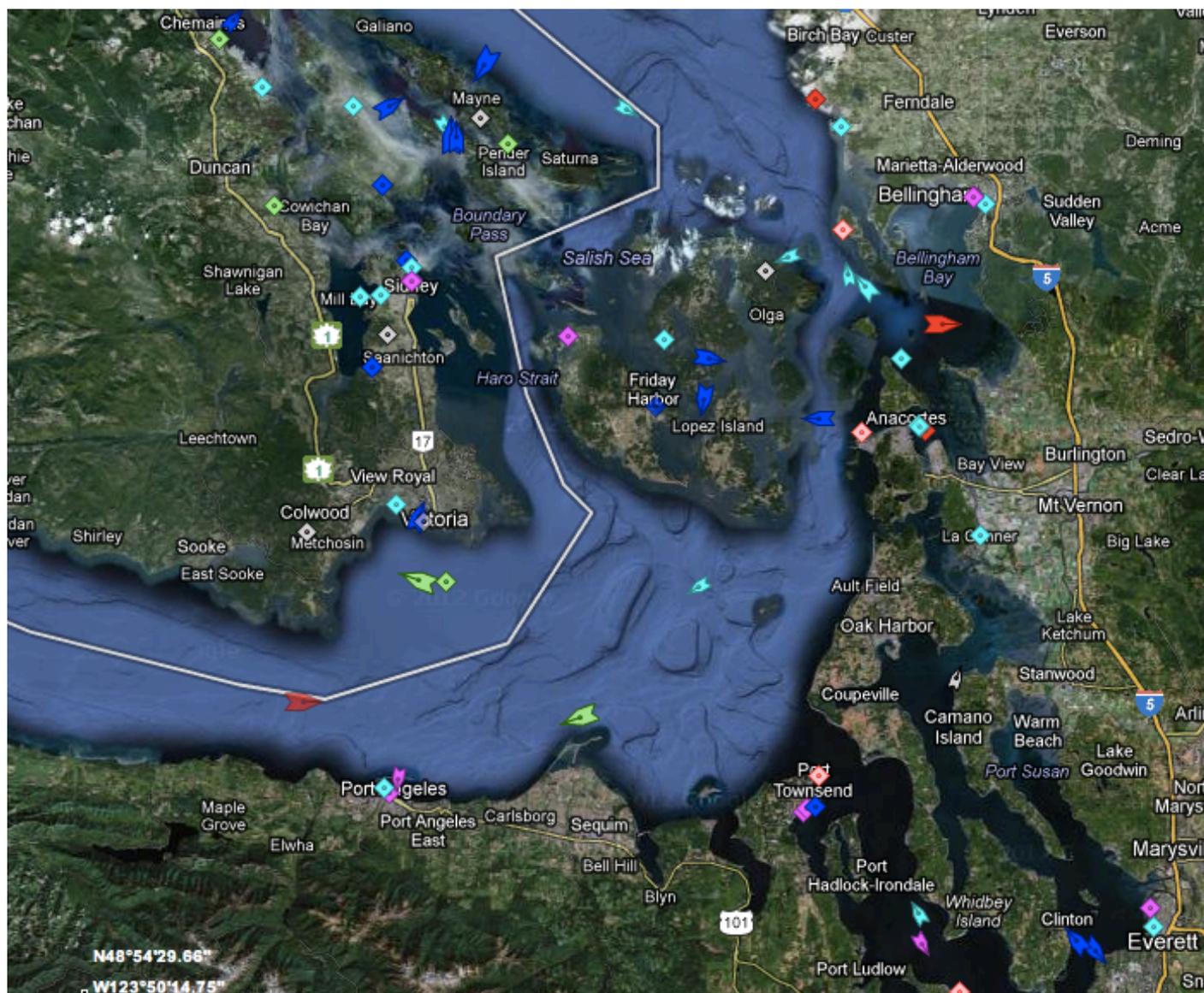
current crop of chartplotters and radios offering AIS display features. Boats like ours are allowed to use "Class B," which is limited to lower power and less frequent transmission than the Class A stuff that the big boys get to use... but it's still pretty magical to have a live display at the helm, showing the tracks and names of other boats in the neighborhood.

For my navigation console, I chose the [Vesper WatchMate 850](#) after much research. This has lots of interesting features, including low-power operation, anchor

watch, and the ability to initiate calls by name to nearby targets via VHF... but I have not yet fired it up so it's a bit early to talk about it.

Instead I want to tell you about my *other* bit of AIS gizmology... a receive-only station at the lab that feeds local ship positions to a variety of servers around the world, which then incorporate it with hundreds of other feeds to yield live displays on the web like the one below from [Marine Traffic](#).

"My" boats in this screen capture are the nine around Anacortes & La Conner:



AIS RECEIVING STATION, CONT'D

For each of these, a click will bring up loads of ship info (including photos, in most cases), and there is the option to show the vessel's track, find out where she's going, and so on. It's pretty interesting stuff, and if you browse around the world at that site or [Vessel Finder](#), you can get a real sense of where the action is (and where sailing would be nerve-wracking).

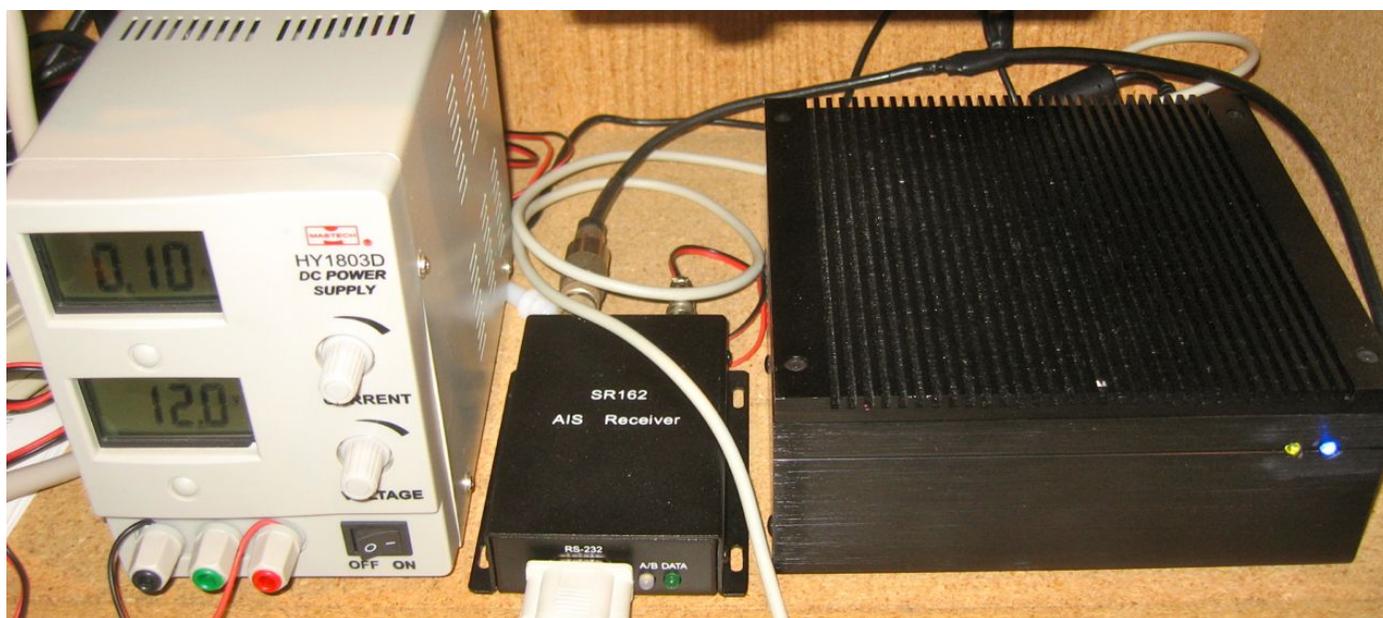
Unfortunately, these displays don't show Class B targets like my little *Nomadness*... but they're still a valuable source of information.

So how do I feed AIS data from 1000 km² or so of nearby waterways into this network?

The photo shows the hardware. A dual-band J-pole (for 2m and 70cm) that I put up a few months ago serves

If you want to understand the encoding, it's all explained [over here](#)... but there is a nifty [online decoder](#) that will do it for you. Using that, we can see that the sentence above is reporting this:

MMSI	: 366772750
Latitude	: 48.521818°
Longitude	: -122.707648°
Speed	: 15.7 knots
Heading	: 269°
Course over ground	: 275°
Rate of turn	: 0°/min
Navigational status	: 0
Nearest place	: Anacortes, United States



as the skyhook, even though it's not optimized for the 162 MHz AIS frequency. That's the PL-259 connector you can see on the rear panel of the [SR162](#), along with the 12-volt power provided by the cheesy bench supply.

The other I/O is the serial cable plugged into the front, the other end of which is attached to a port on the back of the Linux box (dual-core 1.8 GHz fanless machine with SSD, running Debian... idling in this application). That machine in turn is hardwired via Ethernet to my Apple Time Capsule, and thence to the Net.

The relevant bit of code is a utility called [AIS Dispatcher](#), specifically its [Linux variant](#). I invoke this with a simple startup `/usr/local/bin` script with a pointer in `rc.local`, and the command line contains the three UDP targets that are currently receiving my transmissions.

The net effect of all this is a stream of position reports, downsampled to eliminate redundancy whilst keeping the data fresh enough. They look like this:

```
!AIVDM,1,1,,B,15Mj23P02Mo>BOTKhs0rh8K:00S=,0*4D
```

Looking up that MMSI number on the Marine Traffic site, we discover that the position report was transmitted by the [Yakima](#), one of our Washington State Ferries. (MMSI is the [Maritime Mobile Service Identity](#), which uniquely identifies vessels that use any kind of digital transmission, including a VHF radio with Digital Selective Calling. *Nomadness* has her own, which is programmed into the Vesper AIS, Icom 504 VHF, and Icom 802 single-sideband radio.)

If you live in an area with limited coverage (check the Marine Traffic site to see), then I recommend doing this... it's fun! I even have an extra receiver in my [NRL Surplus](#) store for \$150 - it's single-channel scanning, and thus slower, but will work fine for this application.

Although it's a slight distraction from the core mission of geeking out the boat, my shore station has become a useful tool... filling in this region with no other coverage and helping get us better educated about AIS, something that is about to become an essential tool aboard.

Credits: Thanks [Steve Mitchell](#) for all the help on this!

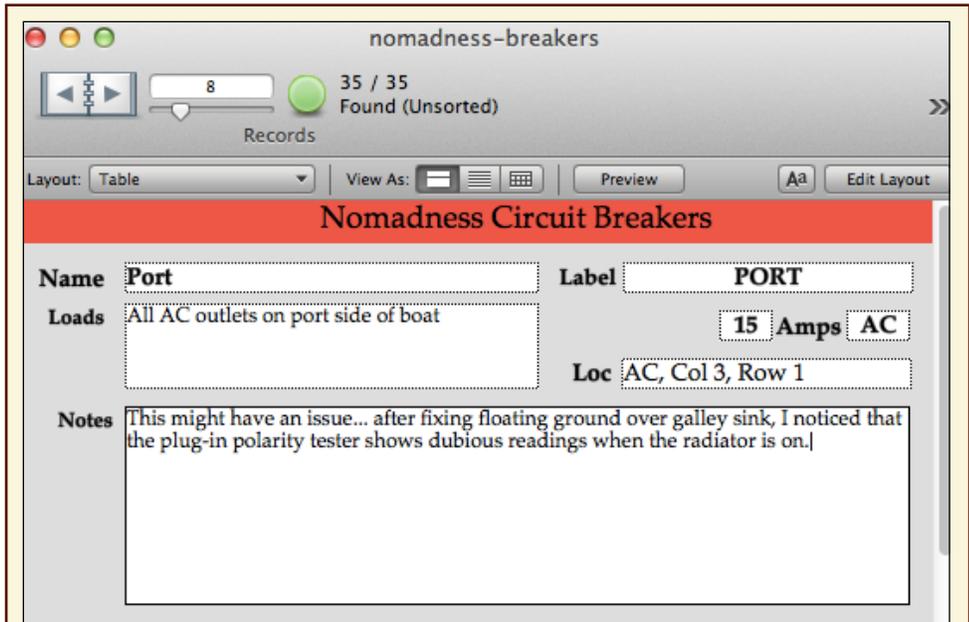
EMPOWERING THOUGHTS

One of the more daunting projects during this phase is a major rebuild of the power-distribution system... the original panel has drifted out of synch with current reality, and the AC panel is nigh unserviceable. I'm moving them to the same console zone, just to the right of the inside helm station, and the new one will hinge DOWN instead of up (what a concept). Being able to physically work on it will make it much easier to refine over time.

The stock photos at lower right show the two [Blue Sea](#) breaker panels that will be used — I was tempted by their new [360 series](#) with its online configuration tool, but it is much more expensive and for various reasons less of an optimal fit. Besides, I already have the AC panel (lower image) as well as their matching AC multimeter. I'll use Front Panel Express to create the substrate panel that holds these, along with the Yanmar generator panel, Outback MATE, and a few other related items. Gone are the antique chromium switches, vintage meters, and objects of unknown provenance.

One of the challenges is figuring out what is there, what I want to keep, and what I need... and map that all to an array of 35 DC circuit breakers (plus a sub-panel in the lab) and 8 more for AC. After staring at ancient yellowed drawings and making lists in the notebook, I finally decided to use the tools at my disposal... so I cobbled together a FileMaker Pro database (above right). This is also viewable as a sorted table, and allows me to collect the various circuit-protection requirements in one place, order the appropriate breakers and labels, and maybe even arrange them in some kind of reasonable order.

The conversion will be non-trivial, though... to avoid excessive downtime, I'll install the bottom-hinged panel in the same opening as the existing top-hinged one, then move circuits one at a time until the latter has been fully vacated. I'm not really looking forward to this back-breaking process, but the end result should be much more serviceable... and congruent with the developing systems aboard *Nomadness*.



MAC MINIS AND INTERNET ACCESS

One of the many immediate consequences of our abrupt shift in plans (August-September 2012 circumnavigation of Vancouver Island) is that attention has shifted from exotic systems to the near-term essentials, enforcing a more logically sequenced approach than my default mode of diving into the übergeekery while letting things like plumbing languish.

In the computational domain, this translates into a simple, off-the-shelf solution for navigation, networking, and general on-board computing needs. Two Macs are going aboard, independent of future console fabrication:

Nav Mac

Located in the small enclosed bay over the pilothouse table, this 2008-vintage Mini will be devoted to navigation, piloting, and other helm operations (including browser and email, of course). With a sunlight-readable Planar LX1201PTI touchscreen display mounted in the helm console, this will be optimized for charting software and similar tools. The display doesn't have the color depth or pixel count to be the main workstation, but for applications like those at right, useful in harsh wet conditions, it's perfect.



Server Mac

The more "traditional" system, if you will, is a 2011 Mini with a Terabyte of dual disk and [Mac OSX server](#). This will support VPN, backups, mail service, and much more... and will have its own bay in the original nav station console on the port side of the boat. There's a physical desktop there (lifting to expose paper-chart tools, with the freezer under that), and there's room for a decent consumer LCD, [Brother laser printer](#), Fujitsu [ScanSnap](#), and all the networking goodies. This will be the place to write, produce podcasts, work on video or photo projects, and so on.

Rogue Wave WiFi

The delightful contraption at left takes most of the tinkering out of connecting to a hotspot, and with 800mW and a good stick in the air, the range is superb. The [Rogue Wave](#) is based on the well-known [Ubiquiti Bullet](#), but has a web interface that's pretty much point-and-shoot. The trade-offs between them, as well as the [Wirie AP](#) and a few others in the same product space, make for interesting reading in the Panbo [comment threads](#).

I'm a little wary of long-term survivability in the marine environment, so thanks to Steve Mitchell's suggestion I'm adapting the Wirie packaging concept and mount the Bullet in an [Otterbox 3000](#) (after some thermal testing), with the antenna connector protruding from the top. This will mount on the radar arch and uses POE (Power Over Ethernet) to simplify cabling and avoid the losses of long coaxial runs. I may instead use a much larger 2.4 GHz antenna ([Radiolabs](#)) on the arch if I can find a safe place to park the Bullet; the smaller one can just plug into the box, but the large one would break it.

This will replace the [Pepwave Surf Mini](#) that is currently passing my webcam feed, and will be the upstream WiFi connection for the [Cradlepoint MBR1200](#) router that is the boat's internal hotspot.



PolarView on the Macintosh

This is the Planar display being driven by a Mac Mini, running [PolarView.NS](#) from [Polar.Navy](#). So far, I'm very impressed... integration with the Planar touchscreen is smooth, and it does exactly what it is supposed to do... with the added treat of a community layer created by [Active Captain](#). Coupled with GRIB viewing for weather, AIS integration, tides & currents, both vector and raster charts, and the ability to drive the autopilot, this may give my familiar [MacENC](#) a run for its money.

Both the Planar and the Mac run on 12 volts, the latter via a [Carnetix P2140](#) power supply. This device is much loved in the [world](#) of automotive computer geeks, and it even has a USB interface that reveals a rich array of internal operating conditions (with PC-only client software, unfortunately). I'll add a 5V regulator daughter board to support the [fan temperature controller](#).

A HUGE LAPTOP TRANSITION



Speaking of computer upgrades, there is something insane about this photo. At the bottom is the machine I carried around the US on the first 10,000 miles of my bicycle adventures in 1983-84. It has been 29 years between that and the MacBook Air above... and the 2.4 MHz processor has given way to 1.7 GHz. The Model 100 had 32K of RAM for file storage, compared to 256 Gig of SSD and 4 Gig of RAM on the Air. Both were insanely liberating for their time... and the old one was much more expensive (inflation-adjusted).

I always find such things a little unsettling. If I'm alive 29 years from today, will the dusty old Air feel like a cheap toy compared to the one interfaced to my cortex?

Long-overdue upgrade

For 6 years, an eternity in computer time, I've been living with the original model of the MacBook Pro. It has become increasingly creaky, and I'm still reeling from last year's hard-disk crash with unintentionally forked filesystems and an ungraceful recovery from scattered backups.

The contrast in specifications between it and the new [13" MacBook Air](#) is not quite as dramatic as that in the photo at left, where the entire file space of the Model 100 is 1% of the memory required for a typical single photo from a modern digital pocket camera. But it might as well be. The experience of using the Air is utterly unlike that of the earlier machines... it's light, strong, and quiet. I thought I'd miss hard drives, but I've adapted... and any lingering mistrust is offset by automatic backups the 2 Terabyte [Time Capsule](#) that also serves as the lab router. It just... works.

Although the current edition of the MacBook Pro is a more robust machine in many ways, I'm finding the trade-offs of silence and ultra light weight to be worth it. If I were making a living at image editing or video, I would of course have a very different opinion... but I'm using it mostly for writing, communications, research, databases, and management.

Email Hell

On the other hand, I'm going a little crazy with something that should be easy. Email has been a central part of my life for 30 years now, and, well, I just sort of assume that the client software vendors would have it together by now. I've been using Eudora for 20 years, and am well-adapted to its minor quirks and comfortable with the brisk toolset. I have many hundreds of nested mail folders that accurately reflect my life activities.

But Eudora is a non-starter in the Macintosh Lion environment (requires [Rosetta](#) translation layer), and I knew I was in for trauma during the transition. It was worse than I feared... all the mail clients out there are flawed in one way or other, most notably the one that I assumed would be the default: Apple's own Mail app!

SO many things are broken about it, ranging from what happens when connection to the server is lost (complete 'modal' hang that requires a force-quit) to limited assumptions about what the user might want to do (can't copy-paste an email address to another app without having to edit out the mailto:). Mailboxes get out of sync, a reply to a forward renames the thread, attached images go inline instead of at the end, indenting gets all screwed up, and more. And it is SLOW once you have a few mailboxes. Complete Fail... glad I didn't move everything over!

The quest continues, with [Postbox](#) currently under evaluation (meh). In the meantime, my archives languish in a POP hierarchy in a creaky old machine.

SHORT SUBJECTS

Remote Power Failure Detection

On Feb 28, my old friend [Bob Stuart](#) (fiberglass guru on the *Microship* project, now living in the wilds of Saskatchewan) commented via email that “you are either having one hell of a volcanic eruption, or the [boat cam](#) is flaky again.” I went down to reboot things, but stepped aboard to discover the DC water circulation pump for the refrigeration system running... but not the compressor. Hmm. AC is off.

It didn't take long to notice that the breaker on the dock had popped, so I reset it and returned to the lab, checked the camera, and found it off again. I flipped it back on and called Al Felker, my marine electrician friend aboard *Finego* just up the channel.

Over the course of the next half hour, we kept scaling back *Nomadness* loads, at last shutting off the breaker to the boat. Still the shore breaker popped. We were about to start looking askance at the cordset with its [SmartPlug](#) when we pulled the panel in the dock breaker box and found 2-3 inches of charred insulation and a parted wire. I was having nightmare visions of leakage through the steel hull, which can be galvanically catastrophic.

Swapping in a fresh breaker and monitoring with a clamp-on ammeter, we then observed no current to the plugged-in cordset (phew!), none with the boat breaker on, and a healthy 15A or so when the *Outback FX2012* Inverter/Charger got busy bringing the battery bank back up from the 76% to which it had sagged since the power failure. All good. As a test, we added heat, refrigeration, microwaving a glass of water, and the water heater... totaling 36 amps and finally popping the main breaker at the stern of the boat.

Our only working theory is that the shore breaker, exposed to the weather in a standard gray domestic steel box, was giving up the ghost, and that the charred wire was left over from a previous moorage tenant (with heat concentrated at the high-resistance screw-clamp connection).

Glad my extra eyes in Saskatchewan were open, or the battery bank could have gotten dangerously low! Ah, technology... I think an improved monitoring system is in order; this is the sort of thing that can become an expensive disaster.

Webasto Air Top 5000 Back Online

A couple years ago, my diesel heater quit working, and when I was doing the conversion to Wema sensors for the fuel-monitoring system I discovered that the dip tube in the starboard wing tank only went 2/3 of the way to the bottom. Sucking air is a famous gotcha on these things, and the solution is fairly trivial... disconnect the fuel line at the heater itself, disconnect the cable to the dosing pump at the controller, and reconnect one lead to ground. You then tap-tap the other lead to the +12V terminal, crudely generating impulses that operate the pump, watching the tube as it discharges drops of diesel fuel into a small jar.

Supposedly, this is the way to clear the bubbles... not taking the *Webasto* through multiple startup cycles (which I had tried before understanding the problem). Also, it is definitely necessary to disconnect the tubing while doing this... I had tried to clear it without doing that, unsuccessfully.

I'm happy to report that it solved the problem, and we now have three modes of heat: electric radiator while at the dock, *Little Cod* wood stove, and the *Webasto*. The latter works beautifully now, with forced-air heating to aft cabin, pilothouse, and the lab region.

Little Cod Hacking

The *Nomadness* wood stove is the *Little Cod*, and they now offer a [glass front](#)... but it would be a \$400 retrofit! I'm just now ordering a high-temperature glass disk to replace one of the drop-in inserts, and am mounting a *Caframo* heat-driven fan to the other. I'll report on this in a future issue.

This thing can really cook (and I mean get scary-hot) so one of the first “easy” nodes when I finally get past all this infrastructure stuff will be an *Arduino* that keeps an eye on all the temperatures in the galley region: this and its stovepipe, the cookstove, both refrigerators, and the freezer. It will be interesting to plot the temperature through the course of a fire and subsequent airflow adjustments...

GONZO ADVENTURE, ANYONE?

Microship Available for Vancouver Island Circumnavigation!

This geeky boatlet has been sitting in its lab for a decade now, with no on-water adventures since the [Puget Sound loop](#) in 2001. With about a decade of intensive effort on the project and incalculable cost, that's bugging me more and more... and the latest twist is that I have recently sold the building that houses it, and the new owner will not be patient forever.



I've had the boat [listed on Yachtworld](#) for a year now, and recently lowered the price from \$73K to \$42K. That's an absurdly small percentage of the development cost, but it was a custom project with specific (and

highly geeky) requirements. That's a give-away price, but still too high for most people shopping for one-person trimarans.

But it has recently occurred to me that there's an interesting opportunity here for another approach. We are currently on a countdown toward launching an August-September loop around Vancouver Island... a "technomadic flotilla" of mixed boat types and experienced skippers. This could provide a very supportive context for a Microship adventure...

I'm willing to loan the boat to someone at no cost for this trip (about 1,000 miles). For me, it would be a chance to see my baby fly; for the person who makes the journey, it's a chance to have a wild adventure. Ideally, this would be a shakedown, and said person would then want to actually BUY the boat for grander adventures still, but that is not a requirement.

What is required is that the skipper-to-be have the skills and resources to spend significant time leading up to departure fine-tuning the ship, testing, and outfitting. This person must be reasonably experienced with small trimarans, and comfortable with a wide range of conditions. There are no guarantees here, though the flotilla will certainly provide a bit of a safety



net with mechanical, medical, nutritional, and logistical assistance when needed.

I understand that there is the near-certainty of breaking something, not to mention the inevitable personal risk of going to sea in a tiny boat, and it's OK if it is necessary to abort partway through the trip. Part of the deal, though, is that the logistics are all the responsibility of the skipper... including getting the Microship back to her home port when it's all over (via water or trailer, as the case may be). The skipper must also assume all responsibility for getting hurt, dying, etc... you know the drill.

Here is a [photo album](#)... and an article about the [physical substrate](#).

I'll have to be comfortable with whomever takes this on... it is a rather audacious expedition for a canoe-scale micro-trimaran. Naturally, I'll spend some time getting the skipper oriented to the boat and helping to get the project started, but I am deeply immersed in my own [epic to-do list](#) on S/V *Nomadness* and don't have the resources (time, money, energy, or space) to take a very active role.

I do recognize that this is risky, but the greatest risk is taking NO risk. It's been sad to see the boat just sit there as my own life has moved on, recalling a decade of obsessive focus, industry



GONZO ADVENTURE, ANYONE?

involvement, and more money than I want to admit. Just seeing her on the water again would be a hoot, and I believe she can make it... we are not in any huge rush, and will happily layover in protected harbors to avoid getting hammered.

So, if you have a yen for insane irrational adventure, savor the glory of inappropriate tools, are reasonably mediagenic, and have the energy to tackle something absurdly challenging... then I'd love to hear from you. I will choose carefully, and please understand that the requirements are fairly complex. I have to be as confident in you as you must be in the boat; both are essential for this to work.

The flotilla will depart Puget Sound on August 1 and head north at a leisurely pace, with a side trip to Princess Louisa Inlet for those who wish to take a 3-day detour while others hang around Pender Harbour. This is the opposite of a race, and the boats in the group include sailboats of 25-50 feet and a couple of trawlers. Some folks are only going partway, and will veer off to pursue their own adventures in Desolation Sound or the Broughtons. Participation is by invitation, and some of the sailors have circumnavigated Vancouver Island previously. We'll publish an ongoing multimedia narrative, of course, and will use AIS and APRS to keep everyone advised of the locations of everyone else.

To be ready for this, the Microship needs some maintenance and improvements... so please budget a solid 2-3 months in a nearby facility to get



some chain, horn, radar reflector, ultrasonic wind sensor, and a few other goodies. The recumbent seat is highly adjustable, and can retract onto the after-deck to allow rolling out a camping mattress and sleeping bag. The rig is a 93-sqft vertically battened sail with all controls (vang, outhaul, main, and furler) in the cockpit. Steering is with a pair of comfortable T-handles that provide redundant hydraulic circuits, and the kick-up rudder can be reset from the cockpit. Pedaling is easy to sustain at 3 knots

or so, with much faster sprints possible. I think the electric motor is good for 4-5 knots or so, but it's been a while. The forward-angled kick-up daggerboard is at the turn of the bilge to allow sleeping on board, and there are bulkheaded forward and aft stowage compartments as well as the two amas to provide redundant flotation.

ready for the trip. I have a 480-watt solar array custom-made for the boat that was never fully installed (a significant mechanical project, optional but very cool), and this can run the electric thruster at full blast on a sunny day to make life easy. Hydraulics need to be bled, the pedal drive needs to be lubricated and cleaned, the fabric dodger needs some tweaks to keep the water out when you're trying to sleep, and probably lots of other things. The boat has a VHF and GPS, LED navlights, a robust power system, fresh-water tank with pump, Delta anchor with 185 feet of webbing and

The steerable and retractable landing gear are insanely cool... it's awfully nice to deploy them and pull the boat up a ramp to take a break from it all and avoid moorage fees

when camping options are nearby. On land, harnessed to the forward crossbeam, you plug a winch handle into a hydraulic assembly as shown at left, yielding Ackerman steering as well as a "pigeon-toe" mode to keep the boat from running away on a slope. Commented photos of all this are in the album... the landing-gear system alone gobbled 2-3 man-years of engineering time.

That's enough of a teaser for now... much more, of course, if I hear from likely candidates!



SHIPNET DEVELOPMENTS



Bringing Systems Up to Date

Over the four years I've had this boat, there have been a few complaints that have become something of a litany. Perhaps the loudest of them all has concerned the lack of a chartplotter at the outside helm (inside, I used a Mac laptop running MacENC... a fragile, fair-weather solution).

Standing outside, trying to navigate with only paper charts on the breezy cockpit table, has been a nuisance (and at times rather unsafe, with a near grounding or two as well as one last-minute turn hard to port to avoid an island!). When I first bought the boat, I came very close to a pair of Furuno's then-new NavNet 3D systems... but their product rollout was awkward and I lost my nerve.

Well, it's time. The technology has come a long way, prices have dropped, and my needs are much more clear. In this article, I want to start discussing new developments in the ship's comm, nav, and instrumentation systems... the photos at left are a teaser.

One of the discoveries in all this is that it is absurdly complex...

I don't know how non-geeky skippers even begin to deal with it all. Not only is there an endless flood of competing products (each with its own variations on industry standard terminology), but we are in a protracted transition between networking protocols.

All the old stuff and plenty of new stuff talks via classic NMEA0183, which itself has a few variations (especially where AIS is involved). Whole product categories exist to multiplex, filter, and otherwise munge the stream of sentences... with another breed of gadgets designed to bridge this class of messaging to the much newer and cooler NMEA2000 (N2K). Naturally, that has its own manufacturer-specific connectors, proprietary variants, and complex management tools... some of which are counter-intuitive in the extreme.

Finally, we have "real" computers in this space (along with tablets and phones), meaning that the networks are extended via USB, Ethernet, WiFi, and Bluetooth.

Confused yet?
It gets worse....

Three Boats, Three Networks

I have been incredibly fortunate, in these early stages of building this convoluted system, to have connected with two other sailors with eerily parallel interests. The similarities and contrast between our boats and product choices have added valuable data points, and all three systems are benefiting from the experiences of the others.

[Daniel Collins](#), on the left, has been in these pages before with his Arduino projects and is just heading out from Texas on a maiden voyage this week.

[Steve Mitchell](#), shown at right aboard *Nomadness* last week, is based



in Seattle and works in the the high-end über-networking industry. He's geeking-out his boat as well, using and sharing many of the same tools...

I wish both were on the same dock here in La Conner; there's nothing like brainstorming with fellow techies when taking on an insanely complex project!



SHIPNET DEVICE CATALOG

Device	Protocols	Function
Raymarine E7D Chartplotter with Sounder option & iDevice mirror	N2K, 0183, Ethernet, WiFi, Bluetooth	Outside helm navigation system, bottom profiler, secondary network display, video monitor
Nav Mac Mini	Ethernet, WiFi, USB	Inside helm with Planar monitor, PolarView charting
Vesper WatchMate 850 AIS	0183 (fast)	Receives and displays location/heading of nearby ships. Has own GPS.
Icom M504 VHF	NMEA 0183	Marine VHF radio with full DSC
Maretron DSM250 Display	N2K	Displays wide variety of instrument data
Actisense NGW-1-ISO	N2K, 0183	Gateway between NMEA2000 and NMEA0183
Brookhouse AIS Combiner	0183 (fast and slow), USB	Merges fast (AIS) and slow NMEA0183 streams, outputs combined, filtered streams to computer & bus
Simrad AP24 Autopilot computer	N2K	Autopilot (drives hydraulic steering; inputs from wind, chartplotter, control units, GPS, compass, rudder angle)
Simrad AP24 control head	N2K	Console-mounted autopilot control unit
Simrad WR20 Remote Commander	N2K, Bluetooth	Bluetooth wireless remote control for autopilot
Simrad RF300 Rudder Sensor	N2K	Senses angular position of rudder
Maretron GPS100	N2K	GPS/speed/time sensor
Maretron SSC200	N2K	Solid state rate gyro compass
Maretron TLA100 (3 units)	N2K	Fuel tank interfaces (from Wema level sensors)
B&G h1000 Instruments	proprietary with add-on 0183 interface	Vintage instrumentation that came with boat: wind vane, anemometer, water depth
Icom M802 SSB	NMEA 0183	Single sideband HF radio receives GPS position
Maretron USB100	N2K	USB interface for maintenance & diagnostics (PC only)

Network Denizens

This is just the stuff that is already aboard, or on hand awaiting installation. There's more to come, not even counting the later *Shacktopus* system with its network of Arduino nodes (partly justified by the absurd prices that vendors of

N2K stuff charge for simple on/off and temperature sensors).

Goodies on the the wish list include an updated masthead wind sensor, a module that inhales analog measurements from the ancient Yanmar turbo diesel and discharges them onto the network, fuel flow monitoring (Maretron has a [unit](#)

that's much cheaper than the traditional [Floscan](#)), power monitoring tools, alarms, and so on. Once configured with all the arcane cross-connections, this will be the backbone of the ship... hopefully tolerant of revisions as the boat undergoes major changes such as hybridization.

MARINE NETWORKING BLUES

That chart on the previous page is our first hint of why connecting everything together is an interesting problem: multiple communication protocols spanning a decade or two, a variety of vendors (some of whom obfuscate industry standards with proprietary naming conventions or connector types), tricky interfaces that involve a mix of fire hoses and gentle trickles of data, the need to get it all into a Mac, firmware versions that drift out of date but are tricky to upgrade, and a shortage of centralized knowledge (requiring searches through forum posts, blog comments, manufacturer literature, old correspondence, and sometimes even a *product manual*).

With my friends Steve and Daniel working on their boat networks in parallel, it has been interesting to see the emergence of alternative solutions. Both are geeks with extensive Linux backgrounds, and are not at all put off by the need to hack, program, and tinker with things until they work. I'm not by any means through with the design, but already have a real sense of compassion for my *non-technical* sailing brethren... along with a new understanding of how marine network installers are seeing a thriving business climate ([Anacortes Marine Electronics](#) is hiring, if you're conversant with this stuff and looking for a job around here).

One of the first puzzles that pops up is how best to combine old and new devices. Basically, the old stuff (NMEA 0183) is very much like what we used to just call "serial" in the days before USB; with one exception, it's 4800-baud data that moves one way on a single wire. It's similar to RS-232, but is instead RS-422 — differential transmission for better noise immunity and the ability to have one talker and multiple listeners on each line.

This has been around for ages, and everyone has a love/hate relationship with it. It's simple, sometimes able to talk to normal RS-232 ports, cheap, and universal.

But there are a couple of significant limitations.

First, it's slow... like, *really* slow by today's standards. By the time you factor out the overhead of NMEA sentence formatting and other stuff, the effective data rate is perhaps 350-400 characters per second. That was fine when boats had a GPS and a compass sending updates once a second to a plotter, but as people started doing more and more with marine networking, the deficiencies became apparent.

One early variation was simply a speed bump from 4800 baud to 38,400 baud... this is used by AIS receivers that are hearing and passing along updates from hundreds of other vessels simultaneously. When people want to present this as a layer on their chartplotters, it can look like a fire hose compared to the stately pulse of the GPS. Devices from Actisense and Brookhouse have been introduced to multiplex and throttle such high-speed sources, yielding a combined NMEA output consisting of sentences from all the ship systems.

Obviously, though, this was getting messy, with people buying hardware to compensate for the effects of other hardware... then getting immersed in configuration issues or (more commonly) taking the plug-and-pray approach or just paying experts. It's a mess, layered atop a bad underlying design.

The situation was ripe for a solution, and the [NMEA](#) took an existing protocol from the engine world (J-1939) along with a very well-tested hardware layer (CANbus) and published the NMEA 2000 specification... as a completely closed architecture that must be licensed. The technical choices were sound, but the business model is disastrous, building a walled garden for the benefit of a cartel of manufacturers who are in the club. The effect is that all the "good" equipment on the market uses it, or an even further-obscured



Need a Commercial-Grade Icom M602 VHF with CommandMic II and extra 20' cable?

One of the goodies in the [NRL Surplus](#) department of my new online store is this beauty, still new in box. It is a waterproof, full-DSC rig with all the trimmings, but I needed something physically smaller for my helm and ended up buying the M504. There is a newer model than this (the M604) but the differences are minor.

The MMSI has never been programmed, so this can adapt to its new home without trauma. \$450 takes it!

proprietary variation to force users to buy connectors and accessories from the same N2K licensee.

What a mess, eh? Instead of open networking standards like the ones in all of our computers, we now have secret protocols that have to be interfaced with the old clunky ones still in active use... along with further interface layers to let us partially interact with our boat systems using PCs, Macs, iPads, Androids, and so on (though some vendors quietly use Ethernet).

And, should someone actually manage to reverse-engineer something in the N2K domain, they can't publish it without fear of being sued into submission.

What's a sailor to do?

SHIPNET BASICS

One of the first puzzles that comes up when trying to deal with this mess is how to blend the old and the new... and in my case, that means translating the NMEA 0183 devices as well as an old B&G network (wind and depth sensors). As with most projects around here, that starts on the blackboard.

There are two basic choices: put an interface device at each 0183 source to immediately drop it onto the N2K bus, or combine all the 0183 devices first and interface *that*. Neither is obviously cheaper, though the former has an appealing elegance.

Still, inspired by Daniel's success with his system, I decided to go with the latter solution... especially since it also handles the AIS fire hose (somewhat optional since the Vesper has its own display, but I want to be able to see targets on the charting

systems as well as initiate calls through the DSC marine radio).

In the blurry left side of the photo below, you can see the Brookhouse multiplexer, which is receiving 0183 sentences from an interface widget glommed onto the old B&G network, as well as high-speed AIS stuff from the Vesper. The gadget to its right is the Actisense NGW-1, which has the comparatively straightforward function of bidirectionally translating between the NMEA 0183 and 2000 worlds.

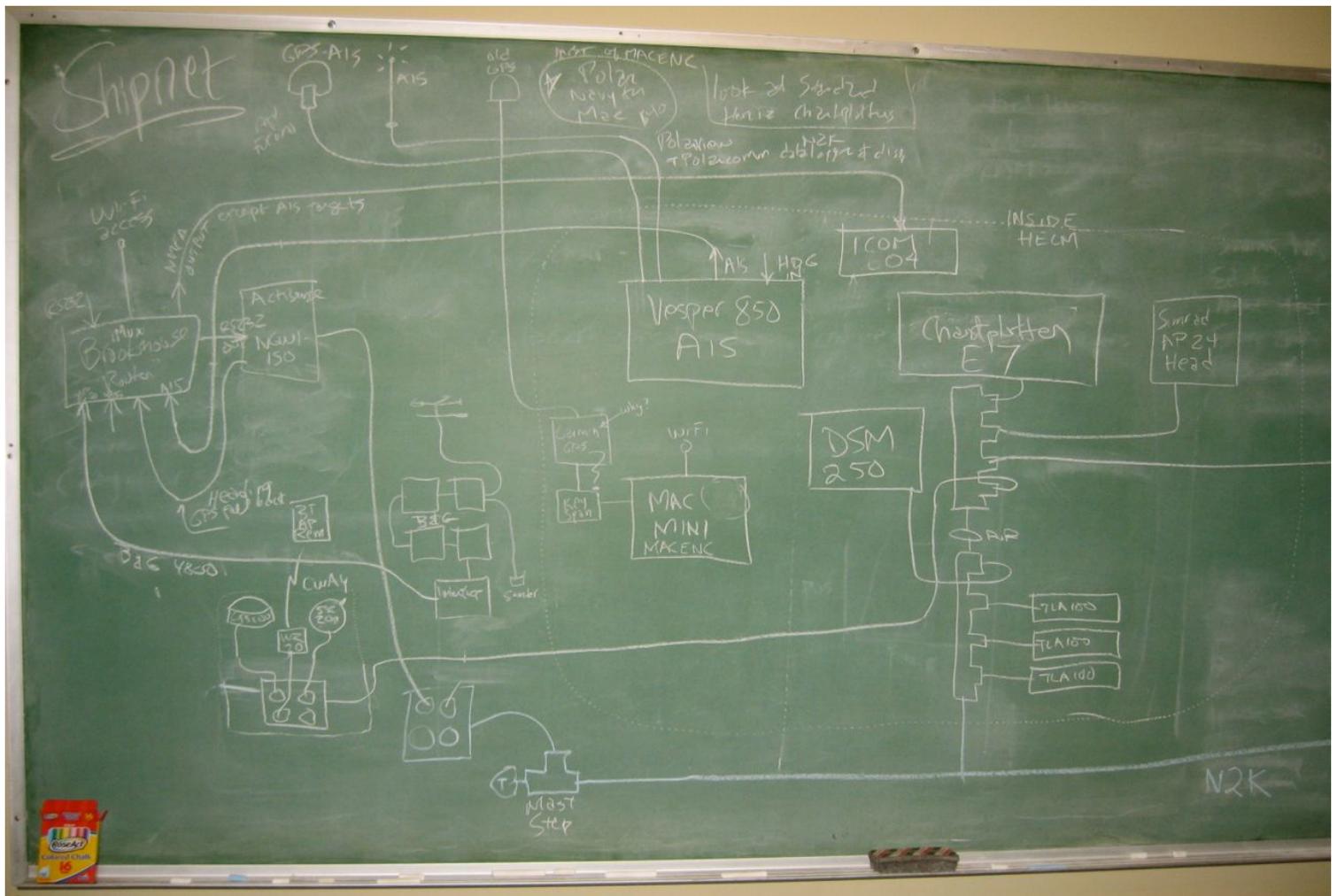
Among other benefits of all this, the marine radio (Icom 504) gets GPS data that originated on the N2K bus (lower left), random computers get to see all the AIS stuff and instrument data (thanks to WiFi or USB interface), and N2K-resident systems like the autopilot can use sensors installed years ago instead of further breaking

the bank by requiring me to upgrade to the latest proprietary gizmology.

By the next issue of the *Nomadness Report*, I expect to have a decent drawing done. If my friends give the go-ahead, I'll present the three systems along with commentary about relative performance, complexity, costs, and ease of use.

If you are scratching your head over all this and looking for more information, I can point you to one of our favorite resources... [Panbo](#). Ben Ellison has been on the marine electronics beat for many years, and his articles, along with reader comments and forum posts, are the best single resource I've found for keeping up with this crazy stuff.

All my network goodies are on-hand, so the next step is hooking them up. Stay tuned!



UPDATES VARIOUS



A New Blog on the Block

You met my partner Kirsten at the end of Issue #16... she's been needing a creative outlet and has just fallen in love with her new camera, the Canon [SX230HS](#). Having played with it, I can see why!

Anyway, I recently set up Wordpress for her at [exploraging.com](#) and she's been doing beautiful work... writing about and photographing DIY and homesteading/seasteading projects. I'm looking forward to being a hungry accomplice in the "Food Porn" category; this homemade sourdough bread is spectacular, and tonight's photo shoot involves pizza. Please check it out and comment if you wish... she's eager for feedback on this new project.



Helm Seat Progress

The helm seat (Issue #16) has been slowly developing as parts trickle in. The photo shows the frame resting on the original "seat"; actual installation will involve bolting the two flanges on the left to the white steel under the teak platform, with holes to pass the 7/8" tubing. A separate strut, not shown, connects the vertical riser to the stern rail, triangulating both horizontal and vertical axes. The entire seat frame hinges up and down, resting on [crutch tips](#) when in use but able to get out of the way for lazarette access or egress through the stern gate. All that remains is bolting it on and fabricating the mesh trampoline with stainless eyelets and tensioning lines.



Polaris Mobile Lab is for Sale!

I've given this a lot of thought, and it makes sense: the mobile lab has pretty much served its purpose here, and is now gobbling expensive space that I need to complete the Camano move-out and set up a shop for dirty work.

This 24-foot lab-on-wheels was featured in Issue #5 ([drop me a line](#) if you want a copy or have questions). It's fully insulated, has a robust marine-grade power system with AC and DC distribution, and features extensive inventory storage with integrated workspaces. The buyer's needs will determine what goes and what I keep... I've already removed the parts drawers, but could easily put them back and migrate my inventory if the new owner sees this as an important feature. Same with machine tools and furniture.

Need a capable mobile workspace? Price is \$25K or less, depending on what fixtures are included.

OUR NEW PUBLISHING SCHEDULE



“Infrequently Weekly but Frequently Freaky”

So goes the tag line for *The Weekly Freak*, a music-scene 'zine published for 17 years or so by my old friend Timmy in Minneapolis. He and some friends were hitchhiking to Oregon for a Grateful Dead show in 1987, and we were on a *Winnebiko II* speaking tour... they rode to Oregon with us in the old school bus (the one launching on page 3 of Issue #4).

I was always somewhat in awe of a weekly one-man rag, especially since my own “quarterly” of the epoch was beginning to look like every quarter *decade*. Of course, back in the '80s it was print layout with clumsy tools and floppies full of files, not writing one document with a Pages template as I do now.

Still, *weekly*? What the heck was I thinking? A few friends raised skeptical eyebrows, but hey, I was on a roll with a new toy. There is never a shortage of material for this wordy old guy, as you've doubtless noticed, but the problem is the overhead.

For each issue, I have to get motivated, set aside the time, select content, set up the files, find artwork, fiddle with templates, update the website, make a thumbnail gallery for the back-issue store, update THAT, edit, agonize over changes, put a copy on the server, take a deep breath, and do the mailing to y'all. The ratio of all those things to the actual WRITING is surprisingly high, and it was becoming a bit overwhelming...

By changing to monthly, I'll spend a lot more time on content and less on putting it out. It will also give me more opportunity to craft substantial feature articles, and each issue will of course have more variety. Fewer files to fiddle with, a more realistic schedule... what's not to like?

There is a bit of administrivia to deal with, of course. I have a database with “last issue” number, and some folks subscribed with an automatic annual renewal. These will kick in automatically via PayPal, while others will get a personal little email offering another year.

The only good deal is one in which everybody wins, of course, so I'll adjust all the subscriptions liberally with extra issues (even the auto-renewing ones), and will also come up with something fun when the design packages start to appear.

In addition, if you haven't already taken me up on my offer of a free eBook of the first 12 issues, please [drop me a line](#) and I'll have e-junkie send you a download code. That will let you replace 12 small files with one big one, and we'll do a similar thing when the next eBook compilation comes out... maybe even with a proper table of contents and some indexing.

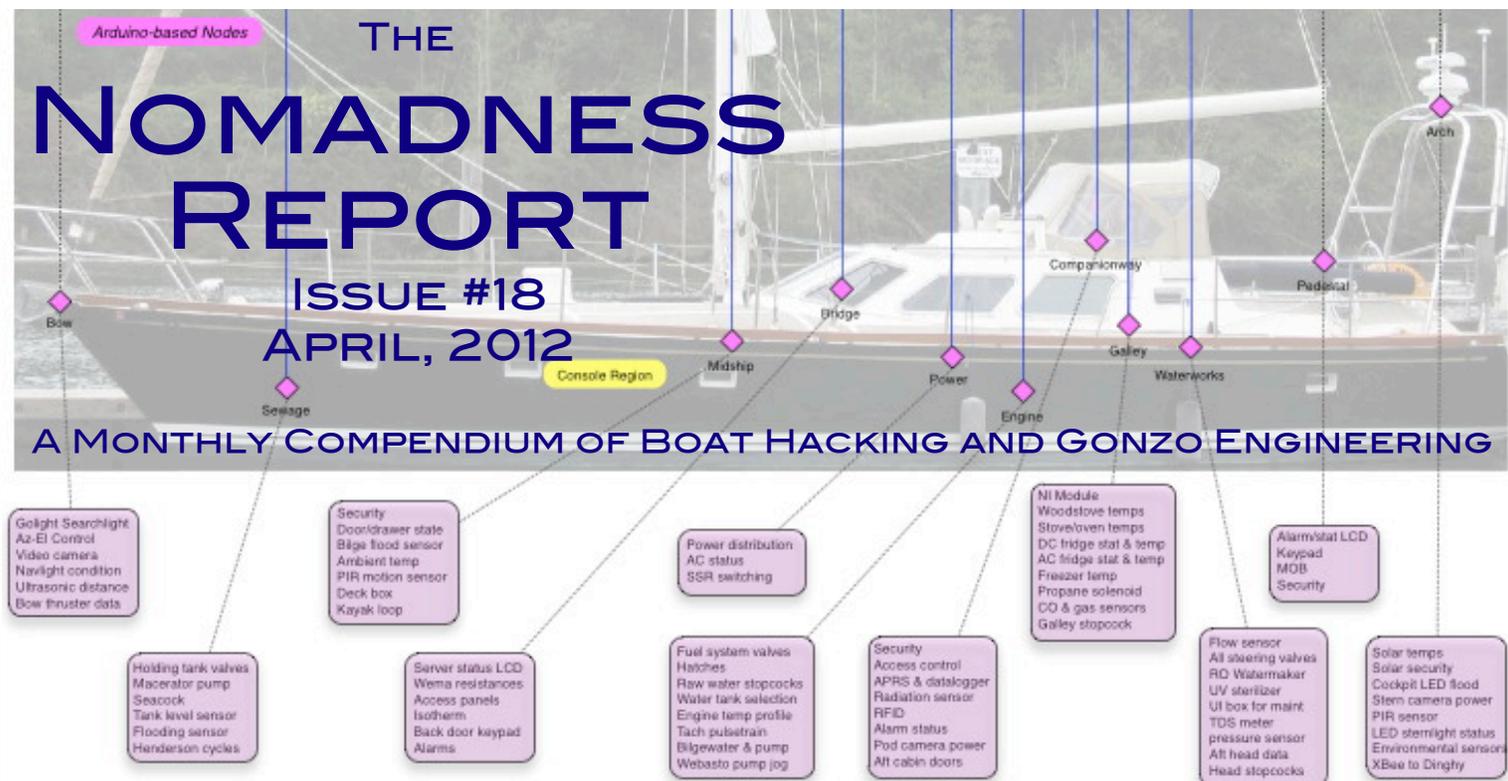
The August 1 departure date will keep things moving briskly, and I'm already looking forward to returning in the Fall and shifting my attention to übergeekery. Until then, however, there is plenty of hard-core boat engineering to document, and I'll be sharing the whole process in these pages. Please tell your friends... subscriptions are the lifeblood of this project!



THE NOMADNESS REPORT

ISSUE #18
APRIL, 2012

A MONTHLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



AIS, HOT TOPICS, AND FINAL VOYAGE

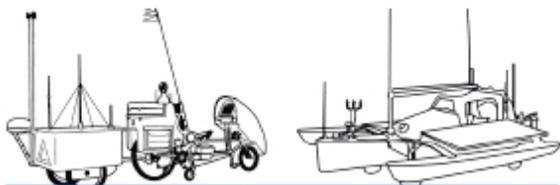
Hello from the *Nomadness* lab! In the month since Issue 17, a lot has happened... some physical work on the ship, the initial burlblings of a huge and exciting lifestyle change, and deep immersion (some of it frustrating, of course) in a rapid turnover of development tools.

With thanks to my friend Steve Mitchell of the sailing vessel *Jammy* (based in Seattle), what began as a brief article about my AIS installation ended up blossoming into half an issue devoted to the subject. He contributed an intriguing technical piece on the way Class B updates are handled by public servers, then addressed some issues with AIS initiation of DSC calls via connected Marine VHF radios.

I move on from there to discuss wood stoves and computer cooling (somehow those seem to fit together), share a few boat-parts photos with captions, then chat for a while about system tools.

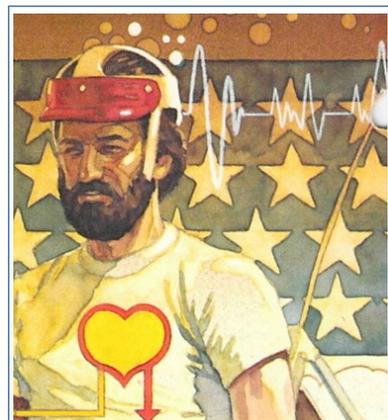
The issue wraps up with a feature article about the development of a *Nomadness* simulation pod to support my final voyage. It's fitting, somehow... both poignant and excruciatingly geeky. Just the way we like it.

-- Steve



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About subscriptions

This publication is available as a monthly PDF for \$20/year... along with eBooks & print editions. Please visit the [Nomadness Report](#) page on our website to subscribe with PayPal, Visa/MC, or check; back issues are available in the [online store](#).

The image above is from the first article in my [Computing Across America](#) series in Online Today, Nov 1983.

VENTURING INTO THE SAN JUANS

I'm not yet sure what this means in terms of the project, but Kirsten just accepted a nursing job in Friday Harbor on San Juan Island (see below; it's a third of the way down under this column of text).

The San Juans are gorgeous, one of the major cruising playgrounds of the Pacific Northwest, and I would love to be moored there during the remaining period of *Nomadness* development. Any move is a huge time sink, however — even a fun one. I haven't finished getting my stuff out of the former Microship lab on Camano Island yet (though I *have* pretty much filled the place in La Conner), so relocation sounds crazy.

At the moment, she is looking for a rental house and planning to commute weekly... 4 days in Friday Harbor and 3 back here. Two residences are not affordable, of course, so the next phase will be for me to move aboard the boat and let the apartment go. (Hey, need a sweet waterfront 1200 square-foot place with a verandah?)

I'm looking for moorage and facilities over there... but I know how complex a quest that can be. For now, the default is for me to keep plugging away right here, down under THIS column of text in La Conner.

I'll keep you posted as the story unfolds! Now let's get on with the fun stuff...



VESPER 850 AIS INSTALLATION

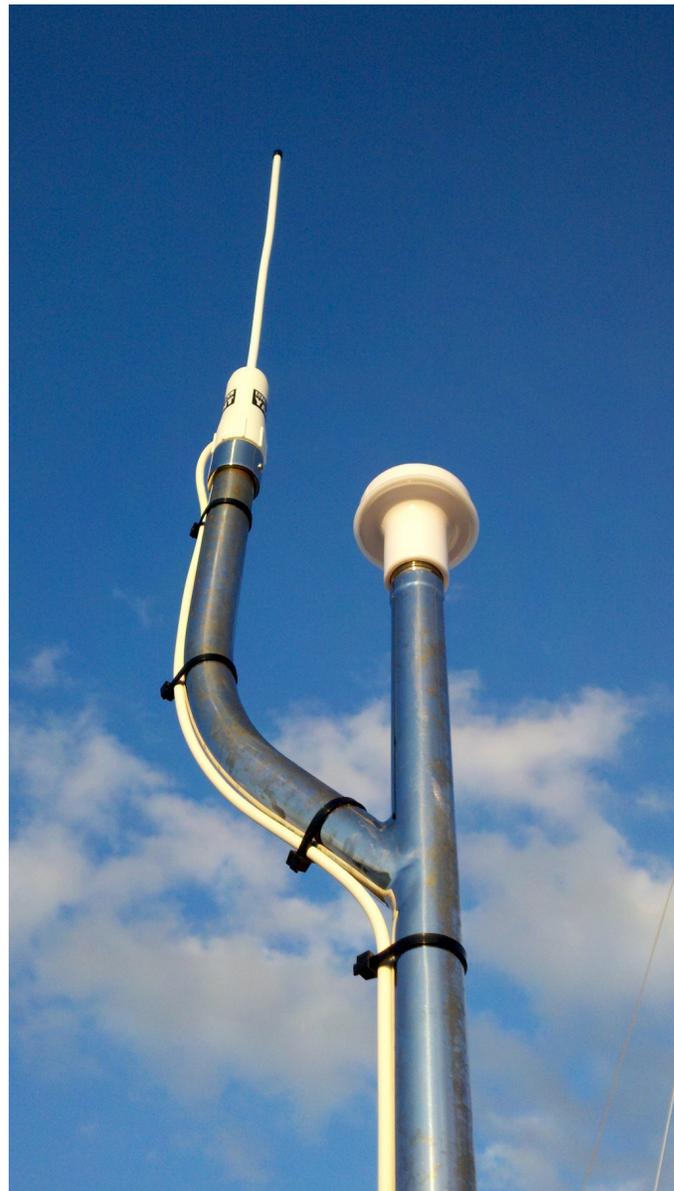
These two seemingly unrelated photos are part of the antenna project for the [Vesper AIS WatchMate 850](#). The unit itself is going at the inside helm station, sharing the space just under the window with the VHF, autopilot head, instruments, N2K system display, and main nav LCD.

An AIS transponder requires two antennas, one each for GPS and VHF. This model actually has an internal GPS (which would have been fine for an outside helm installation), and on the other side there is the option to use an [antenna splitter](#) to share the same masthead antenna used by the ship's marine VHF. I don't like that approach, however, since it introduces both single-point failure potential in a critical area and sub-optimal antenna tuning since the AIS frequencies are much higher than those of the voice channels (around 162 MHz vs 156-158). Depending on the antenna, this could be quite a rolloff... though offset by the optimal placement 60 feet in the air!

Despite that latter temptation, I felt better dedicating antennas to this key system, so I picked up an [AA10](#) for the VHF and Vesper's [external GPS](#). (So far, I'm not hugely impressed with the AA10, and it appears that it's no longer even a current product from [Digital Antenna](#).) The idea was to mount these on an existing structure on the starboard side of my radar arch, formerly carrying a Garmin GPS antenna (for the old 162 receiver) and a Metz that I always thought was attached to the old Furuno Wefax... but wasn't connected at all.

Naturally, both came with 10-meter cables and I need about 12 (this *is* a boat, after all). Initial tests have thus been conducted on the floor..

The antennas mounted more or less without incident (see photo), though the 1" tubing had a standard threaded mount on the straight section and nothing on the spur... requiring an adapter. Also, the Digital Yacht AA10 has a cable exit out the side, requiring that rather ugly lashup with cable ties.



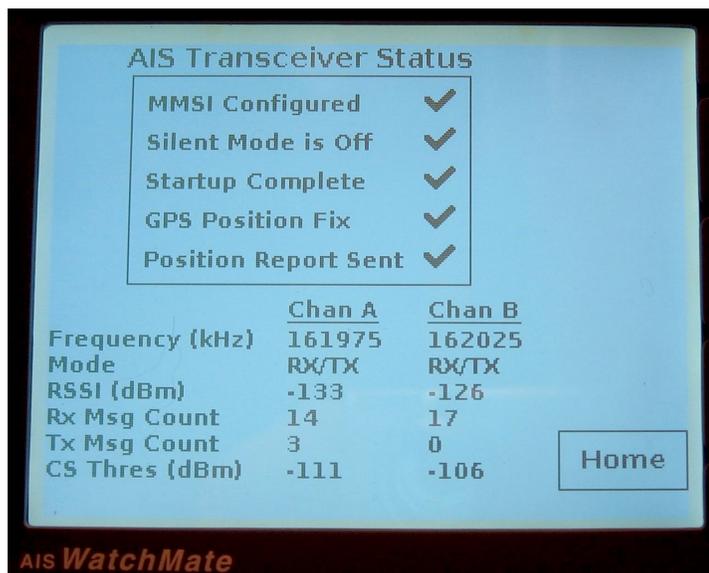
From there, the cables pass through the arch and into the stern hydraulics bay, then along the starboard cable channel to the inside helm. And that leads to this second photo... a place in the aft cabin that has always been a dead zone, inaccessible and stuffed with random cable tangles pulled through or abandoned over the years. It's been on my list to deal with this...

So I picked up a low-end Tempress hatch (also discontinued, oddly) from [Fisheries Supply](#) and did a bit of surgery. Running cables is now considerably less miserable, and I even picked up a couple cubic feet of stowage space as part of the bargain.

At this point, the AIS installation is done but for cable extension and physical mounting.

Well... does it work?

AIS RECEIVING STATION, CONT'D



This is what I see in the backwaters of the Swinomish Channel when first turning on the WatchMate. Above, it has completed its startup check and gotten a position fix, has begun receiving reports from other vessels, and has transmitted three of its own. Since I'm not moving, these are *static data reports* as opposed to position reports, carrying a simple payload that associates my *Maritime Mobile Service*

Identity (MMSI) with information that lets *other* ships display human-readable information... as in the second screen shot above, showing the tug *Vulcan* docked .35 mile north of me. If she were moving, that would be indicated; if there were collision potential, I would hear an alarm and the screen would change to display our relative vectors and closest point of approach (like MARPA in a radar unit).

This is a transmission from *Nomadness*, picked up by my AIS receiving station described in Issue 17, transmitted over the Internet to Steve Mitchell, and decoded to yield this screen capture.

You can see the essential information about my boat, including the MMSI number, FCC call sign, the maker of the transponder, antenna location, and the fact that she's a sailboat.

My grumbling about the antenna on the previous page is related to just how little traffic I see... compared to friends with similar units out in the open Salish Sea, I can almost hear chirping crickets. With a quarter-wave antenna on the arch (instead of the masthead), and VHF propagation being line-of-sight, I am only seeing tugs, barges, and fishing vessels near me in the channel. But where are my fellow *sailors*?

Let's hand this over to Steve Mitchell for a while, since he has been wondering the same thing...

Description	Value	Value Description
Creation Time Local	17/03/2012 09:39:50	
Nmea Sentence	!AIVDM,1,1,,B,H5NF,fTTF!	
AIS Sentence	!AIVDM	Mobile class A or B, 168 bits (28 6-bit words)
Fragments in this message	1	
Fragment No	1	
Sequential Message ID		
Radio Channel	B	
Payload	H5NF,fTTF5C@5B0G45ml	168 bits (21 8-bit words)
Fill bits	0	
CRC check	33	
Vessel Name	NOMADNESS	
AIS Message Type	24	Class B CS Static Data Report
Repeat Indicator	0	Repeatable
MMSI	367365050	
MID	367	United States of America
Part no	1	Type 24 Part B
Ship Type	36	Vessel-Sailing
Vendor ID	VESPER	7 characters
Call Sign	WDE5329	7 characters
Dimensions to Bow	13	meters
Dimensions to Stern	1	meters
Length	14	meters, {calculated}
Dimensions to Port	3	meters
Dimensions to Starboard	1	meters
Beam	4	meters, {calculated}
Spare	0	6 bits

AIS PUZZLES: CLASS B & DSC

by [Steve Mitchell](#)

S/V Jammy

AIS is a great tool for sailors and landlubbers alike, but there still seem to be some unknowns where there shouldn't be...

I was thrilled when AIS was first announced, and even though in the "early days" only commercial vessels could carry transponders, I was still transfixed with watching ship movements for the first time on a computer. Nowadays, as Steven covered in last month's *Nomadness Report*, you are able to purchase a transponder (commonly referred to as a Class B AIS unit) and transmit your vessel details, location, and many other things out across the airwaves for others to consume.

I purchased an SR-161 AIS receiver as soon as they came out, and remember having it setup in my house watching Elliott Bay and the general Seattle area. I used [ShipPlotter](#) running on a dedicated PC to create my own custom map of ships nearby. I bought another SR-161 and installed it on the boat, and had it setup to send data to my chart plotter through a mux. It was a lifesaver in terms of being able to [see ships around land masses](#) and figuring out the best way to navigate in and around the bay. (*Note from Steve R: I have an [SR-161 for sale](#) if you want to try this.*)

Flash forward a year or two, and I had installed a Class B transponder and was broadcasting my vessel details, just like many other folks.

Lately, I had noticed that my AIS transponder wasn't working quite right, and after a couple of weeks of investigation, determined that it was failing. It was about 3.5 years old, completely out of warranty, and would cost quite a bit to fix. The symptom was that it wasn't sending out my vessel's information as frequently as it should, and it was randomly restarting – not the reliability I wanted for something I had come to use frequently in busy areas. So I decided to replace it with the unit I had been eyeing for quite some time – the [Vesper Marine WatchMate 850](#). More on that below...

In troubleshooting my failing AIS transponder, I started by using tools like [marinetraffic.com](#) and [vesseltracker.com](#) – setting up email alerts for when my boat was "seen" by their systems. After getting randomly different alerts from both systems, I began to doubt the quality and frequency of the data from those services, particularly for Class B (recreational) systems. I also knew that some of this might be related to the failing unit that I had, so I was eagerly awaiting my new WatchMate.

As part of this new system, I opted to replace my AIS antenna and GPS receiver, as the ones I had

already mounted came with my other transponder, and weren't as high quality as I would have liked. I chose a [Shakespeare Galaxy 5396-AIS](#) 4' antenna, and mounted it on a 3' extension on the stern rail, putting the tip of the antenna roughly about 13' above the waterline, much higher than my previous one. I also purchased the [external GPS antenna](#) for the Vesper WatchMate and mounted it on the stern rail as well, although much lower.

In addition to this, I applied for an international MMSI through the FCC so I could legally travel to Canada and elsewhere, and have an appropriately licensed radio.

The Class B Puzzle

To connect the Vesper to the rest of my network, which was all NMEA 2000 except the VHF radio (ICOM-M504) and the WatchMate, I used an [ActiSense NGW-1](#) that was directly connected to the WatchMate on the NMEA 0183 end, and to the NMEA 2000 network. ActiSense offers a [downloadable firmware image](#) that conveniently changes all of the settings you need on the NGW-1 for an AIS device – baud rate to 38400, various PGNs and sentences setup the correct way, etc. I adjusted only a couple of the AIS sentences from the NMEA 0183 side of the gateway, and my WatchMate was transmitting its data onto the NMEA 2000 network. My Simrad NSS7 chart plotter, Raymarine i70 displays, and my PC via Coastal Explorer and the NMEA 2000 gateway all now had access to the AIS data being sent out by the WatchMate.

So, back over to [vesseltracker.com](#) and [marinetraffic.com](#), and I created identical alerts for my new MMSI. However, the same thing started happening again – intermittent data showing that my vessel hadn't checked in but once a day, sometimes twice. I knew that my AIS transponder wasn't the problem, so I started investigating more angles.

At the same time Steven was going through similar problems. He has the same WatchMate unit which he installed on *Nomadness* around the same time, and a receiving station of his own that he covered in last month's *Nomadness Report*. After working with him on trying to figure out why *Nomadness* wasn't showing up frequently either, I asked him to configure `aisdispatcher` (the Linux software grabbing AIS stuff off of the SR-162 receiver) to send my server the same UDP stream he was sending to [marinetraffic.com](#).

I grabbed a spare laptop running Windows and installed [Ais Decoder](#) by Neal Arundale. This is a great, lightweight tool that allows you to parse AIS data in many different formats – serial, UDP/TCP network streams, log files – and look at the resulting information in various ways. I used this to parse the UDP stream Steven was sending me to verify

THE AIS CLASS B CONUNDRUM

Nomadness was reporting correctly. Sure enough, within the first few minutes I saw a "Class B CS Static Data Report" which showed all of the correct data! This type of record is sent for vessels that are Class B and are not moving more than 2 knots – essentially anchored or moving slowly.

(This is what is visible in the screen capture back at the bottom of page 4.)

Over the course of a day or two, I watched all of the data coming from Steven's receiver with *Ais Decoder*, and tried to figure out patterns between the raw data and online AIS sites. I couldn't find a reason why I could see valid position reports from *Nomadness* every 3-6 minutes, but no record on those sites. According to the AIS spec (which Siitech has a great write up on [here](#) specifically for Class B), we should see reports every 3 minutes if we're not moving at least 2 knots, and the servers should parse this information and display our vessels. (See image below.)

I eventually installed [Siitech's Web VTS Mate](#), and [AIS Server Mate](#) products on a dedicated Windows 2008 Server in preparation for running my own AIS station, and had the stream from Steven going to both *Ais Decoder* and the the Siitech server. The Siitech server and accompanying web front-end are excellent commercial products and have a lot of great options. However, even with this server, I still wasn't seeing Class B vessels, even though I know that there was data being submitted via Steven's UDP stream.

So I took my old ACR Nauticast Class B transponder – the one that was failing – and with the PC software it came with, reconfigured it to be in receiving mode only. I setup a Linux box running Debian, installed *aisdispatcher*, and found my old AIS antenna. I set this all up at home and placed the antenna in the window. In about 15 minutes, both *Ais Decoder* and the Siitech server reported that I was seeing about 100 different vessels, but Siitech said none of them were Class B.

The screenshot shows the AisDecoder software interface. The top window, 'AisDecoder - Control/Stats', displays system information (03-31-2012, 18:34:53), time zone settings (Pacific Daylight Time), and various control buttons (Start, Pause, Stop, Options, Update, Help). A 'Stats' panel shows: Received (346), Waiting (0), Processed (346), Filtered (346), Outputted (692), Scheduled (0), Named Vessels (34), and Last Output (0). The version is 3.1.0.99. The 'Nmea Input' window shows a list of received Nmea sentences, including Class B reports for vessels like CAPE GREIG, PINNACLE, F/V ROSELLA, HENRY FOSS, NORDIC FURY, SEA STORM, HUSKY, and CONFIDENCE.

The 'Summary' window at the bottom displays a table of received AIS messages:

Sentence	MMSI	Message Type	DAC	FI	ID	Vessel Name	Comments
IAIVDM	367445470	1				CAPE GREIG	Position Report Class A (Scheduled)
IAIVDM	367300280	1					Position Report Class A (Scheduled)
IAIVDM	303072000	1				PINNACLE	Position Report Class A (Scheduled)
IAIVDM	366929780	1				F/V ROSELLA	Position Report Class A (Scheduled)
IAIVDM	368222000	1					Position Report Class A (Scheduled)
IAIVDO	338058937	18					Standard Class B CS Position Report
IAIVDM	366976870	5				HENRY FOSS	Ship and Voyage Report
IAIVDM	366976870	5				HENRY FOSS	Ship and Voyage Report
IAIVDM	366978060	1				NORDIC FURY	Position Report Class A (Scheduled)
IAIVDO	338058937	18					Standard Class B CS Position Report
IAIVDO	338058937	18					Standard Class B CS Position Report
IAIVDM	367078130	1				SEA STORM	Position Report Class A (Scheduled)
IAIVDO	338058937	18					Standard Class B CS Position Report
IAIVDM	367309040	24			B		Class B CS Static Data Report
IAIVDM	367172260	1				HUSKY	Position Report Class A (Scheduled)
IAIVDM	366997290	1					Position Report Class A (Scheduled)
IAIVDM	368231000	1				CONFIDENCE	Position Report Class A (Scheduled)
IAIVDM	367409350	1					Position Report Class A (Scheduled)
IAIVDO	338058937	18					Standard Class B CS Position Report

THE AIS CLASS B CONUNDRUM

The screen shot below of the Siitech AIS server shows the running services. You can see my base station is sending about 122 updates per minute, while Steven is sending about 8. The VTS Server line is the server servicing the web interface, and shows that I (as well as one or two other people) are looking at the data via the web interface.

At this point, I was really starting to believe that I just didn't understand class B position reporting, and the frequency. So I contacted the Siitech folks and asked if their server would be filtering out anything, and was told that it shouldn't. The only thing that is taken

into account is that if you have Class B data that shows the vessel isn't moving, then it might not show up as often because it's not being transmitted as frequently. They also said that often because Class A and more mobile Class B targets are transmitting very frequently (sometimes every 30 seconds depending on what they are doing), it could be that the Class B data is never reaching me because it's not frequent enough. However, I didn't buy that as I could definitely see the data coming from Steven's stream... and mine as well, showing lots of Class B reports.

The screenshot shows the 'Running processes' tab of the Siitech AIS Server Mate v5.14.244 application. The interface includes a menu bar (File, Edit, Help) and a table of processes. The table has columns for Name, Status, In per min, Out per min, and Service. The processes listed are:

Name	Status	In per min	Out per min	Service
UDP from Home AIS Linux Station	Listening			UDP server
UDP from Home AIS Linux Station (10.0...	Active	122		UDP server
UDP from Steven	Listening			UDP server
UDP from Steven IP hidden for privacy	Active	8		UDP server
VTS Mate Database	Error			VTS database
VTS Server	Listening			VTS server
VTS Server (10.0.1.140:9007, AIS)	Connected		125	VTS server

At the bottom of the window, there are buttons for 'Options...', 'Map...', 'Start', 'Stop', and 'Restart'.

After a few more emails back and forth with the Siitech folks, we were still not able to resolve it. They sent me to their free service called [VTS Lite](#), and it shows plenty of Class B targets, but not my vessel on a consistent basis.

At this point, I still do not have a clear picture as to why most servers, both public and private, are not showing data that is consistently making it to them. Steven is sending data to at least three different sources, and I'm gathering his data and my own data, and have looked at hours of logs showing consistent Class B reports, yet I rarely see them on the various maps. I am still waiting to hear back from Siitech on exactly why their server isn't displaying these targets.

The only logical conclusion I can make at this point is that the servers are hard coded not to show Class B

vessels that don't report with a specific frequency. It would be great if vendors would allow us to change this default.

My short term plan is to deploy a couple of [Comar SLR-200N Network AIS receivers](#) – one at home or the boat, and one on Maury Island where I have a house so that I can gather more data and send it back to my dedicated AIS server. I intend on opening up that AIS server to others who are in the Puget Sound area who would like to send their data somewhere where they can be assured that they will have full access to it the minute it is transmitted. I'll pass that URL and more info on when I am completed with this project. If you have an AIS stream already, feel free to contact me – I'd be happy to consume it and display it for you.

AIS AND DSC GROWING PAINS

AIS Take 2: The DSC Puzzle

So back to the AIS installation.... One of the other major reasons for wanting the WatchMate, other than the usual ones of having a dedicated AIS display, was the new DSC calling feature they [announced back in December 2011](#). This allows you to find a vessel on the WatchMate display, and initiate a VHF DSC call directly to them – extremely handy. I contacted the folks at Vesper, and got everything upgraded to the new version, but quickly found a problem.

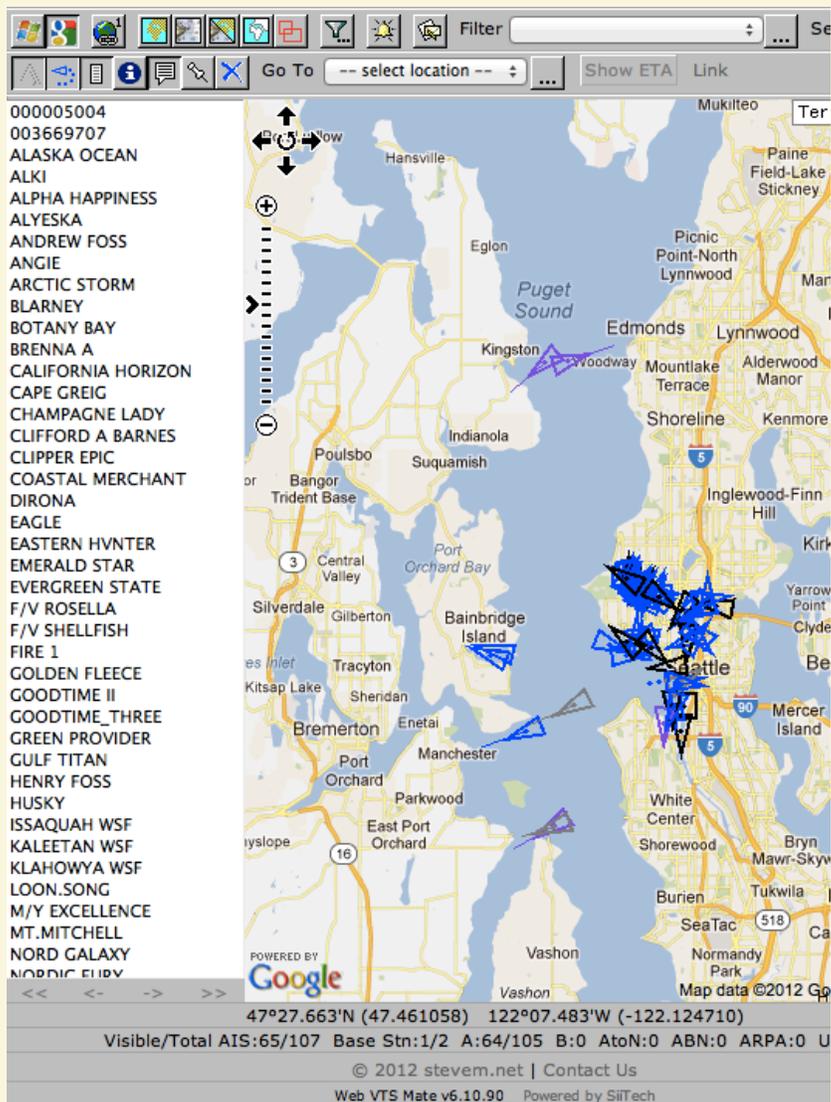
My architecture is mostly NMEA 2000, and as I mentioned above, I use two ActiSense NGW-1's – one for the ICOM M504 VHF radio, and the other for the Vesper WatchMate 850. ActiSense supports DSC sentences with the NGW-1, and I had previously configured the ICOM NGW-1 to send and receive these. The WatchMate NGW-1 was setup to send and receive AIS, and I also enabled it to send DSC as well.

However, the Vesper folks said that the WatchMate only transmits DSC sentences when it's set to 4800 baud, which disables sending AIS data onto the NMEA 2000 network. You may recall from above that I want AIS data on the NMEA 2000 network so that the Raymarine i70 instruments in the cockpit can display an overlay, and alert me to any issues, without me going below to the WatchMate. In addition, I wanted the AIS data on the network for the chart plotter and other devices. Changing to 4800 baud, and turning off transmitting the AIS data on the network wasn't going to work for me.

After some emails back and forth with the Vesper folks, it was determined that they designed this feature to work with VHF radios directly, most of which only support 4800 baud. Additionally, it was designed to work directly connected to the radio, which can't process AIS data, or connected to a multiplexer.

We're now discussing whether they would be willing to change it to transmit DSC sentences at 38400 baud, as well as continue to transmit AIS data. There is some debate over whether ActiSense would process this correctly at both ends – about a year ago folks on [Panbo](#) were discussing how the NGW-1 didn't have support for DSC sentences, but I am almost 100% sure I have seen it and configured it – this was a few months ago – with one of their newest firmware updates. This should allow the Vesper to send a DSC message using NMEA 0183 @ 38400 baud to the NGW-1, it will translate it to a NMEA 2000 PGN and put it on the NMEA 2000 network, which will then be caught by the NGW-1 for the VHF radio, turned back into a NMEA 0183 message at 4800 baud, and sent to the radio, which will then queue up a DSC call to the MMSI of the vessel in question.

Regardless of what happens above, it's still very clear to me that there are some key integration pieces still left to solve in the AIS world. Hopefully we will be able to have these systems function well together very soon.



HOT TOPICS

Computers in Enclosed Spaces...

As I mentioned in Issue 17, the current plan is to install two Mac Minis aboard, one devoted to navigation and the other in the Internet Alcove to be a general server and workstation.

The only problem with this is that even relatively efficient machines cranking out [30-300 BTU/hour](#) can quickly turn an enclosed space into an oven... self-destructing in the process.



Ideally, I'll put each one in a hermetically sealed environment with a heat exchanger. Although that is a non-trivial project in itself, fans drawing air through computers at sea are fraught with peril, with elevated humidity or even saline spindrift depending on conditions (*water corrodes; salt water corrodes absolutely*).

Whatever the eventual thermal design, one key component will be a way to turn on more than the internal fan when the temperature hits a setpoint... and for that, I'm using a pair of these low-cost [fan controllers](#) (and ultra-quiet fans) from [Coolerguys](#):

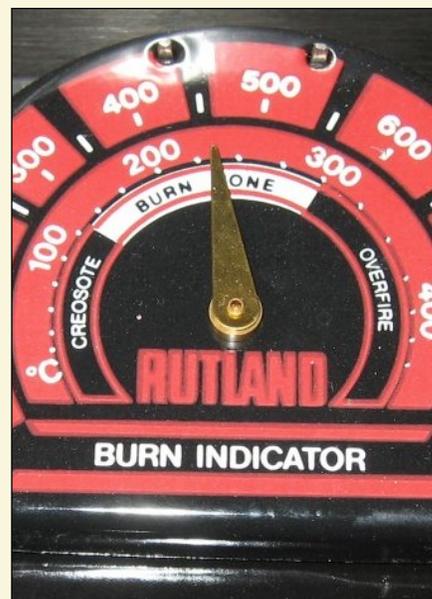


I have not fired it up yet (so to speak) so am not quite ready to recommend the product... but I can certainly recommend the company. They were highly responsive to questions, and even let me delay the order and make a few changes before shipment. Good folks.



Wood Stove Enhancements

I love the [Little Cod](#) stove aboard *Nomadness*, but of course had to geek it out. Here you can see a Caframo fan, which gently ramps up via a thermoelectric element when the base gets hot relative to the fins, helping distribute heat. But the big change is the Neoceram disk at left, a cost-effective alternative to the \$400 glass-front retrofit I was craving. If you have a *Little Cod* or *Sardine*, I can get you one for \$100 (email me). It will take 1292 °F (700 °C) continuous or 10% more in short bursts... and doesn't mind shock. The cabin light is beautiful...



RANDOM TOPICS



Safe and Battery Alcove

This recent addition adds a layer of frustration to any attempt to pilfer little stuff, and makes me feel better about leaving things like the ship's paperwork binder aboard. With Nylock fasteners and free-rotating bolts, it would require carpentry, steel cutting, or safe-cracking to get inside. The opening port is rather obscured, but it was anyway... this was a bookshelf before.

The rest of this region will the Zone of Chargers... cables, wall warts, drop-in bases for handhelds,

Makita power base, and the [Maha MH-C9000](#) charger/analyzer for the Sanyo AA/AAA Eneloop inventory. For too long, I have put up with this stuff being scattered all over the place, and they will be separately switched to minimize phantom loads. The area will have nests for laptops, tablets, Kindles, and phones... the all-in-one charging bay (with some charging possible inside the safe as well).



Clever fender hanger idea, spotted on a classic trawler at the Anacortes Boat Show. This is kind of tempting... sometimes a quick adjustment method would be handy.



At the same boat show, I also spotted this on a [Nordhavn 43](#). That's a swing seat at a little desk cubby, lockable in stowed or active mode by the pin on the lower support bracket. Nomadness currently has a drum throne at the computer station, since it has rubber feet instead of wheels... but it's not comfy. This is a good hack... worth noting.

DEVELOPMENT SYSTEM UPDATE

Email

In Issue 17, I shared a little rant about Email Hell... and I wish I could say the problem is solved. As I mentioned then, I had already dumped the Apple Mail app for various reasons; since then I've also been very disappointed in Postbox, Thunderbird, and now Sparrow. Why is this hard? Various apps suffer from inconsistent threading models, lost messages, or (in the case of Thunderbird running in two completely different hardware and software environments) a habit of freezing with the Spinning Pizza of Doom *many times a day*.

Sparrow has the absurd habit of obscuring received messages that have been forwarded to someone else, burying them below a modified summary. This pretty well kills the basic utility of an IN box.

Postbox lost mail, and has an absurd threading model that doesn't reveal to whom you have replied if you answer one message in a conversation (say, a response to a forward)... yet marks the thread replied. Sparrow does a similar thing, causing frequent confusion. These are broken at fundamental conceptual levels, IMHO (not just buggy like Thunderbird).

I have one more to try (MailMate), with a responsive and friendly developer... but it is already known to be fragile when the archive gets over about 10,000 messages, since they are all in one big soup.

I really miss Eudora, and wish Qualcomm had not abandoned it! The beautiful robust clarity was hard to beat, the search and filtering tools were excellent... over two decades and a dozen machines it never failed me. Since I've moved to this newfangled feature-rich IMAP stuff, I have had nothing but a worsening mess, not to mention an orphaned IN basket on the previous machine with much unanswered, with archives nigh inaccessible. To deal with the latter, I may just move all the history into [DEVONthink Pro Office](#), reportedly an excellent archiving solution.

Security

A minor prowling incident amplified my long-standing paranoia about leaving lots of fancy gizmology sitting around, so I'm finally doing something about it... in the form of [SecuritySpy](#) on a dedicated Mini. This will have four cameras feeding it from various locations, three of which have already been in use around here for a while. The fourth, an [Axis M1011-W](#), is the low end of their new product line. I've been happy with the Axis 210 webcams for a few years (like the [one on the boat](#)), and hope this is as good... I'm a bit skeptical since it feels flimsy, but it is wireless and much cheaper than the older models. Hopefully I'll have a performance report on that and the software in our next issue.

If we get the whole *kitten kaboodle* relocated successfully to Friday Harbor, one of the priorities will be to establish a VPN (assuming the networking infrastructure there is sufficiently robust, which is not necessarily a given). This will allow all the security, backup, server, and sync stuff to feel like it's on the same LAN... an issue that becomes ever more critical as the toolset grows more complex. Just staring at DEVONthink and some of the other new system tools is making my head throb a bit... but it will be worth it, I'm told!

Front Panel Fabrication

This one is a bit premature, since I haven't actually *done* it yet, but I wanted to mention the prime resource for making custom panels. When I first dove into this project, I assumed I would need a CNC machine and spent a fair amount of time getting acquainted with the lightweight units (favoring the V90 or fancier *Comet* from [Probotix](#)).

But really, this is the sort of thing that has created a thriving market for [hackerspaces](#), facilities with shared tools available to members. Being in the boonies, that's never been much of an option... so now what?

In my case, the way to do this is with [Front Panel Express](#), a service that machines custom aluminum panels of most any reasonable size, thickness, color, and tooling path. I've downloaded and played with their free *FrontDesign* CAD program and it's really easy... with such niceties as automatic setup for rack standards, color infill of engraved lettering, corner radii of choice, and a price tag that is updated continuously as you work through a design.

I have a few projects looming (the new power panel, not to mention all the later lab stuff), so it was nice to see a friend go through it and emerge happily. Here's Steve Mitchell's new nav panel, turned out last week:



MY FINAL VOYAGE

Nomadness Emulation

April 1, 2012

Finally, as this issue draws to a close, I want to tell you about the skunkworks project that is underway here at Nomadic Research Labs, shepherded by a hand-picked team of engineers.

We ran an extrapolation of my progress on nautical technomadic projects, including *Microship*. In 20 years, a staggering amount of human time and other resources have been poured into these endeavors.

Along the way, we formulated the *Roberts Law of Fractal To-Do List Complexity*, which postulates that each item on a list is itself the title of a new list. This proceeds recursively all the way down (like the famed turtles), providing endless opportunities for discovery along with the potential for *negative progress* as work is completed (exacerbated by product life cycles and the emergence of seductive new technologies).

Meanwhile, we must contend with the well-known adage that the average completion time of a homebuilt boat is 137 years. While the *Microship* project was back-burnered after only about 10% of that and *Nomadness* is already a perfectly serviceable boat, the layers of added geekery are restoring the developmental time-sinks that were eliminated by the minor detail of starting with something that was well-suited to voyaging before I started tinkering with it.

Lest these combined influences result in one of those never-ending projects that you can find in any marina, we've decided to leapfrog the current trajectory with a system designed to provide adventure opportunities well into my dotage.

The *Nomadness Emulation and Telepresence System (NETS)* eliminates the inconvenient issues of handling a heavy boat and powerful rig with an ever-weakening body — a problem that has led many intrepid voyagers to trade in their sailboats for trawlers. Unwilling to go quietly to the Dark Side, I have decided to replace

myself with a suite of real-time telemetry tools coupled to an immersive simulation pod, providing a toolset for adventure synthesis.

The idea was sparked by a nameless wag who once quipped, "you can simulate sailing by standing in a cold shower and tearing up hundred-dollar bills." On a hunch, we set up a double-blind test to see if this was indeed the case, and while there were numerous flaws in the illusion, we found that 42% of our experimental subjects reacted to the shower chamber with nearly identical levels of adrenaline and cardiac arousal (especially when they were required to use *their own* hundred-dollar bills, an experience that one participant compared to dropping by West Marine for a "simple plumbing problem" before financial issues forced him to quit the experiment).

Encouraged, we decided to extend the metaphor with more of a live boat experience, and pulled out all the stops. Hydraulic control systems drive a helm pod with six-axis motion simulation, including all three translation axes (fore-aft, lateral, and vertical) as well as roll, pitch, and yaw. Background vibration and cross-axis motion are minimized by dedicated closed-loop controllers with accelerometer feedback, faithfully reproducing the streaming input data with critical damping.

Our visual production team surrounded the helm pod with a large dome that is essentially a "hemisphere plus," allowing us to present the illusion of wave patterns that go negative relative to the apparent horizon. A dedicated network of graphics processors provides gigapixel, flicker-free imagery at about 60 frames per second, depending on wearable Polhemus sensors to devote the bulk of this considerable processing power to the region bounded by the pilot's current gaze vector and further optimized in the foveal region as detected by laser retro-reflection.

Since the real *Nomadness* is not yet complete, all initial testing of the NETS has involved simulated data...

something that has been entertaining for all concerned. Roll-overs and knockdowns are as easy to generate as a lazy reach or a muggy day in the Doldrums; with environmental controls and saline nozzles, it's just a matter of coordinating fluid-physics emulation with the corresponding reaction of the simulated ship. Seasickness was initially a problem, but after some fMRI data collection we were able to synchronize kinesthetic and visual data. Powerful broad-spectrum illumination induces melanin synthesis when needed, and of course we can hammer the helm with wind of sufficient velocity to complete the illusion of a gale.

Still, it doesn't take long for the novelty to wear off when you know it's just a simulation. Phase 2 involves a massive real-time data feed from *Nomadness* herself, including everything from a suite of high-def cameras to accelerometers and environmental sensors. The link is bidirectional, as the ship is unmanned to optimize the illusion of being there.

When complete, the pod's wheel, instruments, lines, winches, and other affordances will transmit live command and control data to the ship, driving end effectors coupled to corresponding components (amplified by a *feebleness constant* to compensate for my aging). Even biological factors are taken into consideration; invoking the zippered man-hour extension facility to utilize the 4U2PN2 device (rail emulation if outside, head if below) is fraught with a level of peril matched to the current PSD plot of accelerometer data... since we realized that taking a lazy leak in the middle of a gale would shatter the illusion.

It remains to be seen how well remote socialization works, but we are preparing a series of tests involving anchorages, marinas, and raft-ups... with a crusty avatar engaging as needed with live sailors.

Once complete, the NETS pod will be installed in the extended care facility where Kirsten works, and I will move aboard to while away my sunset years in a voyage of discovery.

APRIL 1, 2012

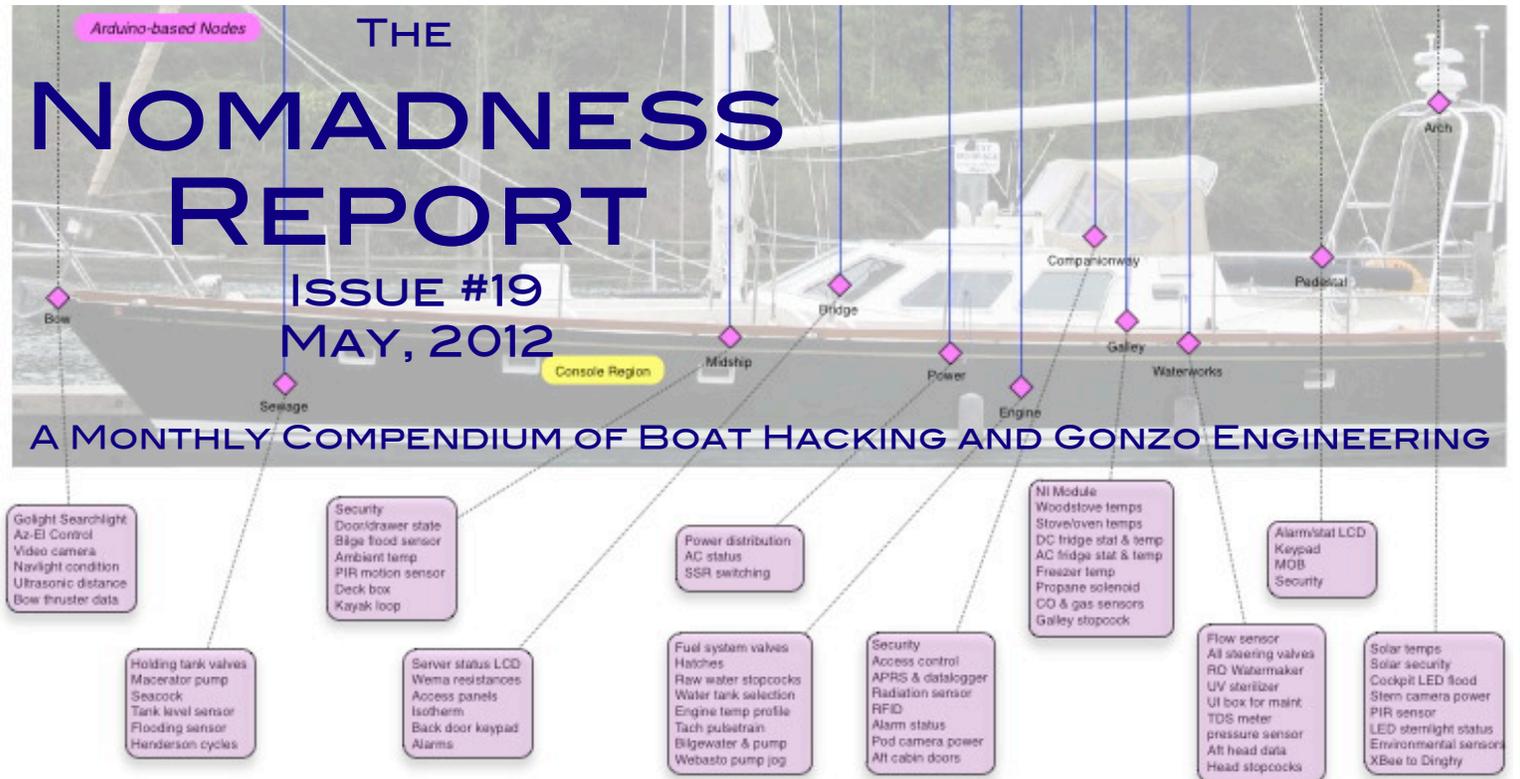
PARTING SHOTS



THE NOMADNESS REPORT

ISSUE #19
MAY, 2012

A MONTHLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



ON TO FRIDAY HARBOR

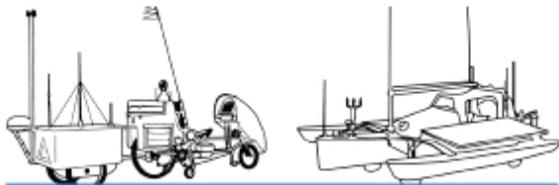
This issue took a while... moving is hugely disruptive! As you will see in the following pages, though, it is going to be worth it on all levels.

Even as the hauling of tonnage (my curse) gobbles time and energy, the schedule of leases has created an inflexible deadline for an essential class of boat projects. Things that involve co-conspirators on the mainland, like the solar array structure and lab desk, move to the top of the list... along with projects that will make the sail to the San Juan Islands safer or more interesting. That, and relocating the lab while still using it.

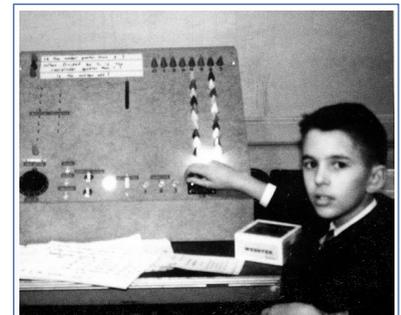
In the following pages you will find a sort of sampler of all this... details on the new facilities (dock and shop), a follow-up on the magnetic curtains, a private head compartment for the kitty, introduction to the solar fixtures, comments on looming and completed projects, and a guest article about an improved version of my companionway step seat.

It's amazing how a single trigger event can be a life nexus... Kirsten's new nursing job in Friday Harbor has launched a cascade of welcome changes that I didn't even know I was craving. This will be fun!

-- Steve



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The photo above is from my 1964 science fair project, when I was 11. I've always had a thing for front panels and blinkies... and am very eager to turn my attention to the Nomadness consoles!

FRIDAY HARBOR... NEW DOCK

Was it only two issues ago that the Vancouver Island circumnavigation was driving the project schedule? Amazing how things can change in such a short time...

As I mentioned in the April issue, the whole project is relocating to Friday Harbor on San Juan Island. I couldn't be happier about this, though the process is back-wrenching and expensive. I am using the *Polaris* mobile lab trailer (two loads so far), and the ferry fare is \$297 per round trip. (GVWR? What's that? I cram it full and go at high tide to avoid the steep ramp at the ferry dock... making no more trips than necessary!)

In the last issue, I was looking for moorage and facilities; both have since been found and leases signed. I'll be moving from *five* separate locations with stuff (boat, apartment, lab, *Polaris* trailer, and the old Camano place) to only *two* (boat and lab). Kirsten has a sweet condo just above my slip, which simplifies details like WiFi and life logistics; she is already moved in and working full time at the new nursing gig (which she loves).



The new slip was a real stroke of luck... my friend Jim Guy (photo on next page) has a thriving business [building docks](#), and got the contract to rip out the old creaky ones at Cannery Landing and replace them with new aluminum structures and grating platforms. I have had the unusual experience of inspecting my future dock as it is being welded in the shop, as well as looking in on construction as the project proceeds.

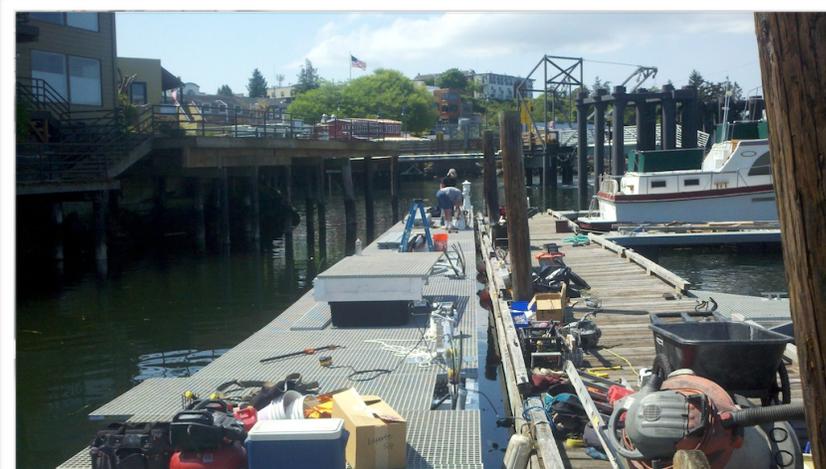
The photo at lower left is the first new finger to be installed in our little marina — it's not the one for *Nomadness*, but is identical. And the photo below is the view that I'll be enjoying from the boat... note the short run (about 3 boat lengths)

between the slip and open water for sailing! This contrasts dramatically with the long, shoaling, high-current channel that has been a bit of a disincentive to day sails... especially with the need to time the return perfectly.

That big piling is part of the ferry terminal; I am immediately next to the parking spot for a 382-foot, 8000-horsepower monster! The wash is not as bad as expected, but those pre-dawn horns... we'll see.



NEW DOCK PHOTOS



FRIDAY HARBOR... NEW LAB

OK, so the boat has a parking spot, but what about all my stuff? I need a lab, a shop for dirty work, office space, music studio, *Microship* and *Polaris* parking, a shipping department, a place to assemble Expedition Medical Chests and other products, and a zone of tonnage for things that eventually need to go away.

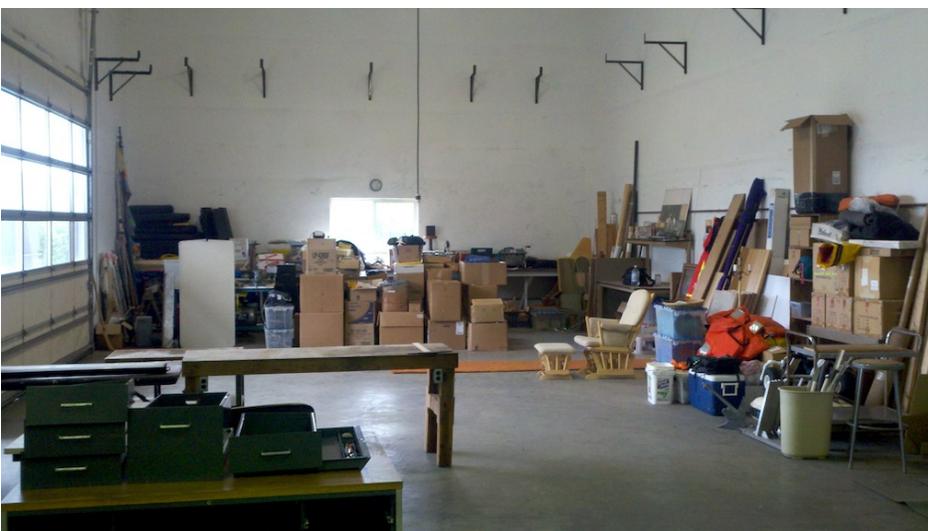
Finding such a place was not easy, and the quest included inland barns, sterile tilt-up industrial buildings, expensive retail space, and even aircraft hangars (it was a busy month of questing). And here... a stroke of luck: the former home of a marine stainless business, now sharing a building with an excellent bakery and the town's food cop! Uh-oh...

The owner is wonderful, already becoming a friend; everybody I meet around Friday Harbor says, "oh, Mark! He's so nice..." This is an admirable quality in a landlord, and indeed he is proving to be very flexible and welcoming. I bought his old Bridgeport milling machine, and in email he reminds me to stretch. This is all a good start to the 2-year lease... which helped get the price down to about what I have been paying in La Conner.

Parking for the *Polaris* trailer is fine for the rest of the year, which will hopefully give me time to find a new home for the machine. Ceiling in the main overhead-door area is about 20 feet, and in the top photo you can just barely see the other region... I have the first bay. A new wall has since been added just before that warmly lit area, and we'll put in a window; that region will be office, lab, and machine tools. The huge open area containing the first two trailer loads in the bottom photo will house inventory, *Microship*, dirty work area, shipping, and other bulky stuff.

There are built-in workbenches and other features, but it is spartan... some effort will have to go into making the lab/office/studio space warm and comfortable.

My largest concern is probably the .7 mile distance between this and the boat... about a 15-20 minute walk (though I'll inevitably find a bicycle to speed this a bit... driving *Biggus Truckus* would be ridiculous). I already get a little



FRIDAY HARBOR... NEW LAB

frustrated with the constant running back and forth between boat and lab in La Conner, and the building is at the *head of the dock*; any closer and it would be flooded. My new digs will require better planning of shop time as well as a more complete suite of tools and parts aboard the boat (desirable anyway). Popping across town every time I need a different size socket wrench or a longer 8-32 machine screw is simply not an option.

But I'll adapt. I'm actually really excited about this, since it will all be under one roof... in La Conner I've been walking a few blocks every time I need to use the drill press, table saw, sander, compressor, or big vise.

As I mentioned above, I'm buying my landlord's old Bridgeport, and that's it on the right. My last mill was a Rockwell in the Bikelab over 20 years ago; like that one, this will be named Cecil (because, you know, *Cecil be da Mill*). It will be used for general fabrication, although I still intend to do consoles with [Front Panel Express](#). A TIG welder is available when needed for the stainless jobs, and I'm otherwise pretty well set up in the tool department.

An integral part of this whole formula is better on-board workspace... and that is underway now (the June issue should have some good photos). My friend Fred, who bought my previous facilities on Camano Island, is in the process of fabricating the boat's lab desk... with laminate over 1.5" of birch plywood, with sheet steel under the surface in the central region to support magnetic fixturing. The whole thing is almost eight feet wide, and will support the rack consoles as well as tool cabinet, piano, and cable management. This, along with some serious attention to parts storage, should reduce the need to trot back and forth between boat and building for every task. Ask me in a few months how that works in practice...

The immediate issue, however, is getting moved in and set up. I'll try not to bore you with logistical details, but that will occupy center stage until July. I'm getting to know the Washington State Ferry system very well as a passenger; starting sometime next month, I'll have a front-row seat at the terminal... for better or for worse!



MAGNETIC CURTAIN FOLLOW-UP

This seems like such a trivial thing, but it has been maddening... remember wayyyy back in Issue #6, with the article "Privacy in the Fishbowl"? The seven curtains for the huge pilothouse windows were sewn with powerful [N52 neodymium magnets](#)... and identical magnets were bonded to the aluminum window frames. Initial performance was excellent, but as soon as they got hot in the summer, the 3M foam mounting tape began to sag.

I replaced the original stuff with something much worse from McMaster-Carr... and they started falling off at an alarming rate (not just creeping as the others had). Compounding the problem, as the magnets slammed together in the resulting pile of failed curtains, the adhesive decided to get aggressive after all, bonding the magnets to each other and in some cases becoming one with the beautiful blue Jacquard fabric. Not nice.

For a while I was planning to glue the magnets to the window frames with a marine adhesive sealant, then realized that this would create a serviceability nightmare when it comes time to replace the glass (already urgent on the forward window over the inside helm, since the double pane is filling up with water).

Then it hit me... magnet brackets screwed to the wood! This solves a number of problems at once, including the difficulty of sticking flat stressed objects to stepped surfaces and finding a foam-core adhesive that won't creep in the localized greenhouse of each window assembly. Here are a few photos of the project as it developed.

I started by whipping up a batch of 50 angle brackets, crudely hacksawn, sanded, drilled, and countersunk:



These were ready to bond with a quick bit of emery cloth and solvent, but the recycled magnets were another matter... annoyingly persistent adhesive that had been clamped between them for months. No mechanical method would remove this stuff, so I had to resort to a

nasty toxin ([xylene](#)) which made short work of the problem... though it dissolved latex gloves and required careful handling. This, plus the excellent [Gorilla epoxy](#), made up the goo inventory for the project; in the photo you can see the magnets providing their own clamping pressure against a stray steel bracket and the xylene can:



I did these in small batches (one curtain's worth) since the epoxy set so quickly...



MAGNETIC CURTAIN FOLLOW-UP

Drilling holes into the window frames would have been impossible with my unaided Makita drill... I had about .75 inch of clearance between the plane of the glass and the axis of the screw. Fortunately, my new favorite tool was at hand... a [Milwaukee right-angle drill attachment](#):



That made it easy to position the magnets where they should have been all along... but without the problems of adhesion to the uneven interface between window frame components. If I were doing it again, I'd use countersunk oval instead of flat heads, and would take the time to properly fixture the countersink for consistent depth. But I really needed to get those curtains up... tourists were walking the dock and peering in...



I am quite pleased with the net effect, and the curtains can be easily pulled away from any corner for a peek outside. Normal rods or tracks were not an option here, and

although I considered larger panels that would mount on the wood surface, the mounting magnets would have been much more visible. This approach is a little maddening

when the curtains are not in use, as the magnets love to wrangle themselves into a tangle, but it is an acceptable solution to an annoying problem.

KITTY HEAD AND SOLAR ARRAY



Isabelle's Head Compartment

One thing about a 44-foot sailboat... there is no free floor space for a messy cat box. I've tried it in both heads and the shower, and in all cases it was annoying.

Problem solved: this is under one of the original seats in the lab region, has easy top access for cleaning, and offers a row of 9 LEDs so she can see what she's doing, apply make-up, and otherwise do whatever she does in there. It still requires me to tidy up with scoop and shop-vac every few days, but otherwise it is out of sight and mostly out of mind except when, well, you know.

An important feature is a curtain made from an antique linen napkin, covering a convenient cutout that was already there for a ventilation panel. It helps preserve Isabelle's modesty.

(Those [strip LEDs](#) are wonderful; they'll be lighting dark corners all over the boat before long, starting with the murky stovetop.)



I should have a *lot* more to say about this in the next issue, since the test fit is next week and we're hoping to have the whole structure done before I move the boat to her new facilities. This is the beginning of a 420-watt solar array.

The larger frame hinges from the radar arch, and is normally fixtured over the dinghy davits... but it can be folded against the stern rail (with the davits retracted) to shorten the boat's overall length when in marinas that use a tape measure for cash-flow maximization.

The smaller one will be fixed in place, extending from the arch to a point just aft of the boom end... supported by triangulating struts. This will provide the initial structure of a removable cockpit enclosure (along with much-needed shade).

Stainless sheets are being bent and welded now, with a water-collection gutter around the perimeter of the larger one. They are also designed to provide much-needed antenna mounting alternatives. You can get a sense of scale in the photo above; that scruffy guy is 6'4" tall.

The photovoltaics themselves will be Solarex Ultralite modules donated many years ago for the Microship project. These are semi-crystalline silicon, and the 48-volt array will be handled by an Outback MX-60 charge controller that is already in place.

SOLAR ARCH FIXTURES



These are the key interface components for the solar array; Derek Peterson created the beautiful stainless assemblies based on arch measurements and long-ago drawings. The clamp-on shaft collars were fixtured to be collinear, and in the photo below you can see one of the units attached to the cross-member of my radar arch.

The intent is to position those tubular hinge axes precisely, and this test-fitting went well with about 1.5" of toe-out at the stern... within anticipated slop range. Nothing on a boat is square, level, or identical on both sides!

Next step is welding tabs to the array substrates, then we can begin test-fitting the entire system before mounting the panels themselves.



IMMINENT PROJECTS

This is a completely crazy time, as you can probably tell; not only is this issue of the *Nomadness Report* very late getting out the door, but I'm bumping up against the end of the La Conner lease and other timing constraints. Great time to break a toe... but that's another story!

As much as I'd like to go find a hot tub and relax for a few weeks with a *Dark & Stormy* in hand, there are events coming up that keep the pressure on... including a few essential projects that are in the critical path to the short hop across Rosario Strait and into my new home waters. Hopefully I'll look back at this transitional phase with a sense of accomplishment; here's a quick look at what's going on (other than moving logistics).

Power

Something that has been on the Real Soon Now list for over a year is a major revision to the ship's power management system... including physical packaging. This won't get done before we sail her over to Friday Harbor in June, but I have to lay the groundwork now... my old friend [Tim Nolan](#) is flying from Wisconsin to spend two weeks in August, working on this with me in a redux of earlier "Geek's Vacation" projects in the Microship era.

There are a lot of pieces to this, but basic objectives are these:

- Eliminate the existing AC panel and integrate the important parts into the main power console*
- Extract ancient irrelevant hardware*
- Install the Charles isolation transformer that's been sitting since I bought it in a hot marina*
- Replace the original breaker panels with new Blue Sea Systems components, including digital metering*
- Fabricate a new power panel, hinged to fold down for less painful service*
- Finish mapping the existing battery management system (which is fine, but only partly documented)*

I have homework to do before Tim arrives, eager to jump in... spec'ing and ordering the DC breaker panel, bringing drawings up to date, having cable and terminations on hand, and doing the CAD work on the new console. I expect to dive into this immediately after parking Nomadness at her new dock.

Lab Desktop

A few months ago I pulled the old dinette and cobbled a wobbly plywood tabletop in the lab region... despite being ugly, this has been extremely useful. But it was never intended as a substrate, just a visualization aid:



Now it is time to get serious, not only to provide workspace aboard but to enable development of the all-important consoles, workstation, and tool storage system. And, as it happens, the timing is perfect: my woodworking guru is ready to take this on, and we have decided to get it done before the boat moves too far from his new shop on Camano Island.

The parts are already on-hand... laminate that matches the headliner, two sheets of birch ply (cheaper than marine ply and ideal for this since it is very flat and will be fully encapsulated), a smaller sheet of thin steel to allow magnetic fixturing in the primary work area, and mounting hardware.

The wing that is at my right in the photo will be a tool cabinet, supported by an angled stainless strut. The rest is for the wrap-around console, and I've relaxed the spec on having the piano pull out on drawer slides or appear under a hinged top surface... that just got too complicated.

The magnetic hack should be interesting, eliminating the need for the wrist-destroying fiddles so common on boat tabletops. I've picked up some [mounting magnets](#) with countersunk holes, along with a [Joby Gorillatorch Flare](#) with magnetic feet.

IMMINENT PROJECTS

Urgent Stuff

And then there are the things that are emphasized in my [online to-do list](#)... jobs that for whatever reason really need to be done before we cast off from the dock in La Conner and undertake the epic voyage to Friday Harbor. Issues here include legal (surviving a random Coast Guard boarding), mechanical (long-overdue oil changes), navigational (mounting the Raymarine E7 at the helm), instrumentation (re-installing the Maretron TLA fuel-monitoring units that had to go back for de-bricking after a glitch involving ancient firmware and a version upgrade), and lots of deferred maintenance.

That public list linked above (which is kind of fun, if you want a real-time snapshot of the current-activity wavefront) theoretically highlights truly essential items by italicizing them, but of course the definition of "essential" changes on a whim. But some things really do have to get done because not doing them creates safety issues... like replacing the Aqua Signal green LED bow navlight that was installed, tested, never used, and then died. Other things need to get done because they represent long-delayed gizmological urges... like the AIS, new VHF, and chartplotter with wireless iPad remote. Still others make the cut because they have simply been annoying for a long time... or would be fun.

Living aboard these past few weeks has already led to a useful re-shuffling of the to-do list; anticipating a sail to the islands with friends aboard is having a similar effect. What this means in practice is that the next 2-3 weeks are going to be a frenzy of boat-project activity, followed by another trailer load or two to the new shop and then the denouement... sailing the boat over!



RECENT PROJECT SAMPLER

A few things *have* gotten done amidst the distractions of establishing a new development site. In addition to curtain magnets and kitty powder room, we have these bits to report...

Companionway Slide Bolt

When my beautiful new companionway door was fabricated by Mike Glanz last year, replacing an old scratched acrylic drop board, we used a temporary little slide bolt that has been annoying ever since. I found a gorgeous stainless unit (ABH model [N1805](#)), and it was recently installed with precise chisel-work by Fred Westergaard... the only thing I will change is to remove the excess aluminum in that spacer pad and add a receiver outside to hold the door open:



Helm Laptop/Log Rack

The inside helm station is a busy place, yet the boat came with key facilities weirdly dispersed into other areas... Marine VHF, wind/depth instruments, and log rack were all a few feet away.

The new layout brings all piloting tools within arm's reach, and one of the first additions was this rack for the logbook, iPad, and MacBook Air. The leading edge was a good place to mount the microphone for the Icom M504 VHF, since I got the model with rear connector to keep the cable from dangling over the main charting display. Details, but they add up...

AIS Temporary Mounting

Issue #18 featured the Vesper [Watchmate 850 AIS transponder](#) that is now working well with external antennas (and public servers; update next issue on that!). Since I have not yet fabricated the new instrument panel, I gave the unit a temporary location at the inside helm, next to the autopilot and above the Mac screen.

The tricky bit was antenna cabling... both the AIS VHF whip and dedicated GPS came with 10-meter cables that were, of course, 2 meters too short. Lots of research led to [Field Components](#), and I am delighted with their custom coaxial cable assemblies.

Shower Seat

I'll spare you the traumatizing photo of my back after the teak shower seat abruptly failed a few weeks ago. Whoever built it wasn't thinking of grain fracture planes, so it was only a matter of time before some galumphing lummoX would split the wood, dropping like a wet soapstone to the shower floor while the razor-sharp edge raked his lumbar vertebrae, one *spinous process* at a time.

No, really. You don't want to see the photo. Trust me on this.

Fred and I discussed the fix, and in this photo you can see him using a biscuit joiner to prepare the parts for reconnection. Once those were installed and the whole thing buttered up with adhesive, he used three bicycle inner tubes tied through the drainage holes to exert clamping pressure.



Still, I'm loathe to trust it yet, even though the joint is reportedly stronger than the original wood. Before perching once again, I'll add a chunk of channel underneath to support the cantilevered section by the one that is properly triangulated.

What other little time bombs await? The oil change from hell, certain unserviceable items, windlass clutch failure with a captive chain... ah, the joys of a used boat!

GUEST FEATURE: VALKYR STEP SEAT

by [Scott Carle](#)

I first saw this table/seat idea in *Nomadness Report #1*, and it was perfect for our companionway. I modified it to fit our needs by doing a cutout on the right side, allowing someone to climb up or down with the table installed. Our companionway is fairly wide, so this left plenty of space for a usable table surface. In mounting it, we drilled holes at every step from bottom to top so that the table could be used for multiple tasks at different levels.

We have used it for several things aboard *S/V Valkyr*, a [Downeaster 38](#):

* It has freed up the space over the fridge that normally holds utensils, mixing bowls of ingredients etc., and has given me much better access to the fridge when working in the galley. Mostly I use it in the top step for this (chest height for me). My wife, who is shorter, prefers to use it in the step below that. I intend to install removable fiddle boards for use at sea.

* It works as an extra seat in the second-from-bottom step. We haven't created a cushion for it yet, but intend to create one that has flaps to attach with velcro or snaps on the bottom of the table. This won't affect the work surface on top when the cushion is not in place.

* I had to replace a filter under the galley sink that faces the companionway. At 6'2" it has always been a very difficult process for me to kneel in the small floor area there and reach under the sink to work. I found that with the seat/table on the lowest step that I could comfortably sit on it and lean forward and access that area with ease.

* Though our pilot berth is mostly a repository of parts and tools at the moment, we will eventually reclaim it as usable living space. I can envision having the table/seat in place on the step that is at the same level as the pilot berth, useful as a table for someone laying there reading... or to hold a plate or cup.

* Our 14-month-old daughter has developed significant climbing ability. The companionway is approximately 5 feet tall and very steep, yet she can climb it in less time than it takes to read this. In looking at the table, my wife realized that if we drilled mounting holes at the front of the step, we could flip the table up vertically so that it covers the bottom step and extends high enough to limit our daughter's ability to climb the companionway. I'm sure it won't work for long as she grows, but



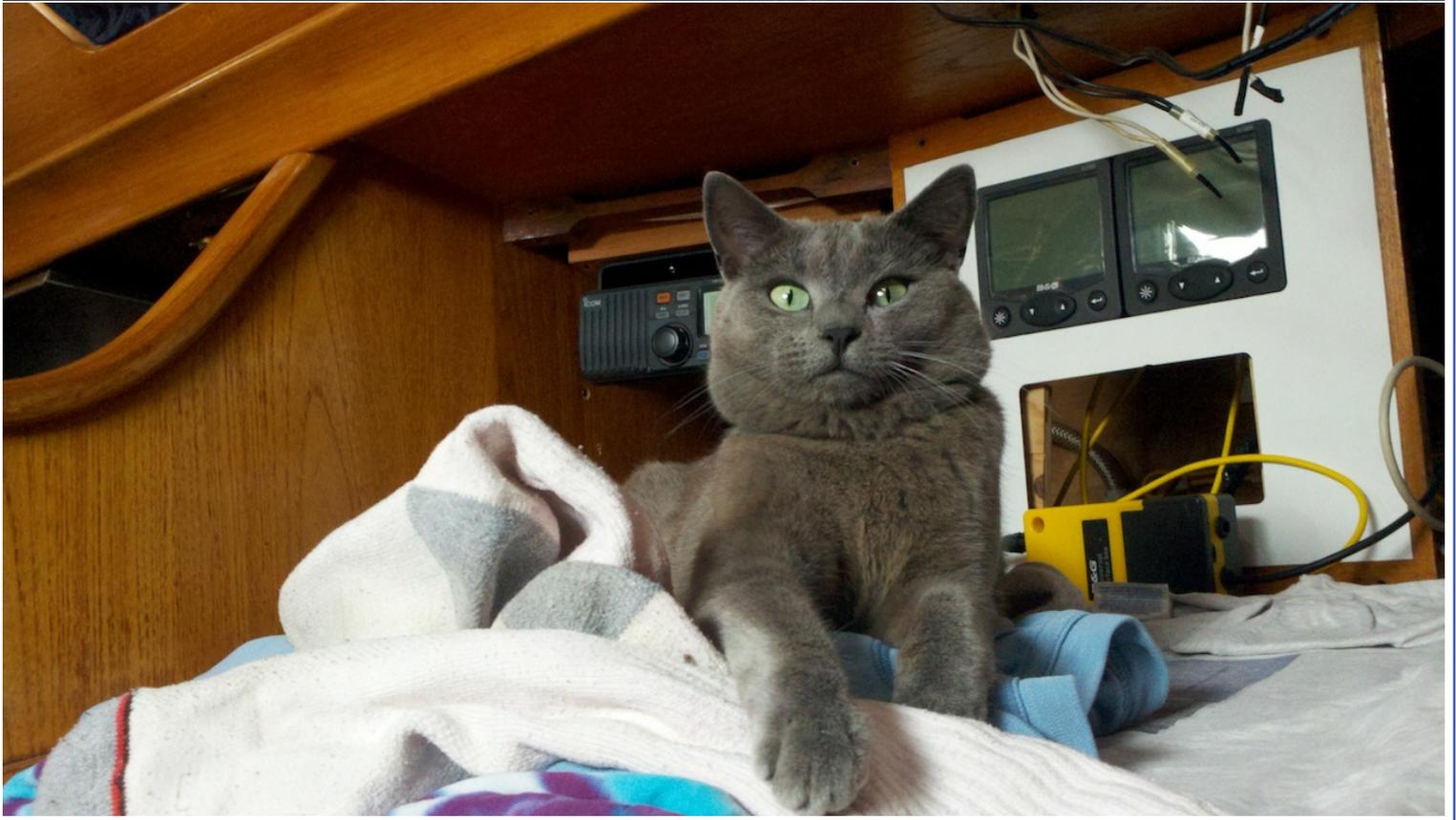
this turned out to be a elegant solution with something we had already built... only two more holes to drill!

The materials cost was only about \$30. We purchased the same [stainless trailer latches](#) that Steve used for his, and I made the table with a scrap of 3/4" birch plywood.

I thought about giving dimensions, but realized that every table done this way will be a custom job. The steps are different widths and depths depending on the brand and model of the boat, and some companionways have steps with no sides... or that are concave with the middle lower than the sides.

Editor's note: great improvements over my design here... I love the cutout and removable cushion! Thanks for the project report, Scott.

PARTING SHOTS

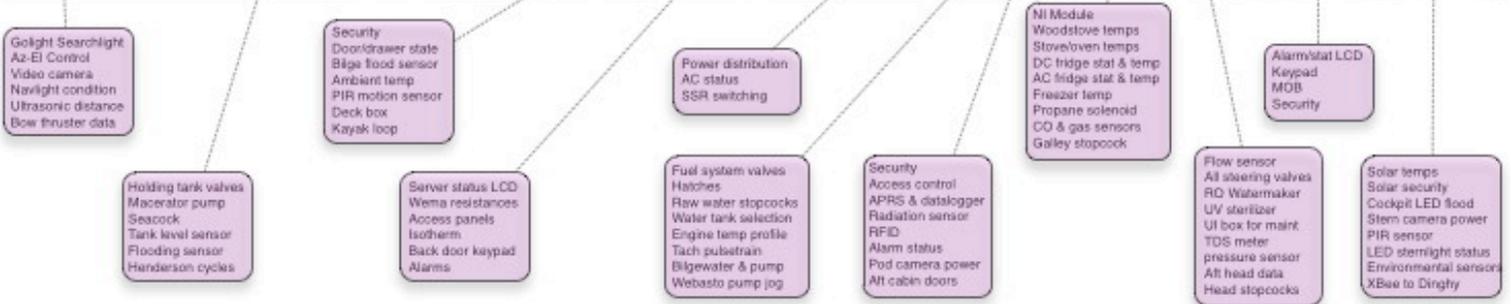


THE NOMADNESS REPORT

ISSUE #20 JULY, 2012

Arduino-based Nodes

A MONTHLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING

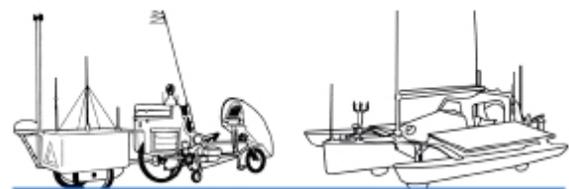


SETTLED INTO NEW FACILITIES

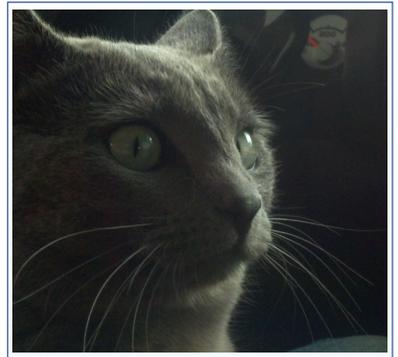
Hello, and welcome to Issue #20! As you may have noticed, I rather skipped June... a large percentage of the past two months were spent moving absurd amounts of tonnage, and I didn't want to devote an issue to logistics and other boring pragmatic stuff. Suffice it to say that Friday Harbor is the new home port of *Nomadness*, and she's bobbing happily at her slip. The new lab, just up the hill, is still a mess, with about 60% of the floor space taken up by a mountain of boxes yet to be unpacked and put to use or eliminated.

Thus begins a new phase of the project, and this issue features a huge part of the on-board substrate that will support that... the lab desktop. While that may just sound like furniture, it's integrated into the boat, carries a tool-cabinet wing, has a steel inlay for magnetic fixturing, and is designed to be dead-flat and strong to handle the consoles without sagging. The next 9 pages describe the construction in detail, followed by updates on a few more obviously geeky bits and a quick obligato tale of the voyage from La Conner on the worst weather day in July... of course.

-- Steve



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The photo above is Isabelle, who first experienced Nomadness underway while motoring in heavy air to our new port of Friday Harbor... horrified at first, then fascinated.

BOAT LAB SUBSTRATE

This is a major step forward; for about a year, I've had a crude plywood visualization model in place of the original cramped dinette table surrounded by stiff cushions, but there it sat... saggy, rough, and not dimensionally accurate enough to use as a basis for any subsequent design. But thanks to the creative efforts of Fred Westergaard, who is turning my old Microship into an exquisite wood shop, the substrate of the lab region is now complete.

The top photo shows the current space, and in the next few pages I'll describe the fabrication of this laminated structure... there are a few non-obvious details, and it was quite educational. Features include assembly in two parts to allow passage through the companionway, an underlay of 16-gauge steel in the central region to allow magnetic fixturing, 1.5-inch thickness and a central stainless post to prevent sagging, a cable-passage corner on the left rear corner, and tool chest integration. From this will flow the wrap-around console of three tall rack enclosures, with a lower one in the foreground to prevent turning the lab into a cave.

The bottom photo shows the space as it used to be. I was never able to get comfortable at that table, pretty as it was, and it was thus a repository of clutter most of the time. Access to stowage areas under the cushions has not been sacrificed, and in the new system I may be able to integrate a deployable pilot berth (with the pillow right at mast base for minimal motion underway.)



2012



2008

LAB DESK FABRICATION

In the spirit of the *Nomadness Report*, I'd like to show you in detail how this was done. It's actually a cool process, and it was most educational to play apprentice with someone who possesses skills so different from mine.

Fred Westergaard, as I mentioned above, is the fellow who bought my property on Camano Island. He is turning it into something wonderful; I had let it languish, exhausted by projects that didn't reach escape velocity and frustrated by the impossibility of working on a distant sailboat while stuck in the middle of a forest. But he is infusing the place with a whole new energy, not only giving the house and grounds a much-

needed refresh but turning the old Microship lab into the ultimate shop he's been wanting for years. All that added an interesting twist to the process of working with him on this project... showing up at my old place to assist. Can you imagine, after spending 13 years there (not to mention being the one who built the 3000 square-foot shop back in 1998)?

The first step was, of course, to plan it out, forcing me to answer the "how high? how deep?" questions with something more precise than vague hand-waving. This is where my tired old plywood model in *Figure 2* paid off, so before long we had some working dimensions... constrained by the need to bring it aboard via a companionway that can only pass items about 32" wide.

The design goals had to be clearly stated as well: a robust tabletop that will not sag under the load of consoles or human weight, solidly attached to bulkheads and supported in the middle, laminated to provide a bright work surface with a steel zone in the center for the magnets, and split to permit installation without compromising strength. We also wanted to include a "wing" at the right to support a 26" tool cabinet, and of course (it goes without saying), it had to be beautiful... unlike the crude mockup shown at right.

(All along, I've been wanting this to have a lifting lid that reveals a full-size digital piano, but our initial



Fig 1

brainstorm session revealed that to be unrealistically complex... and it would have imposed constraints on future keyboard changes. So the MIDI controller will slip into a compartment under the desk and pull out as needed.)

OK, let's build this thing!

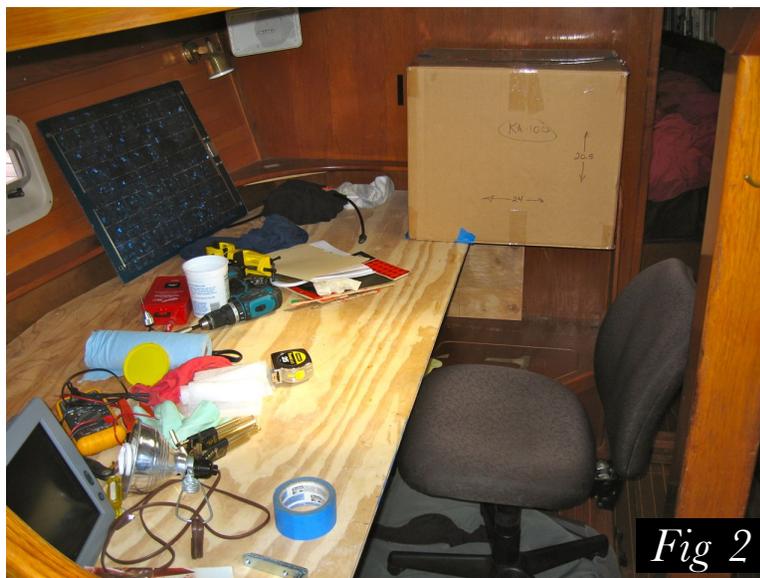


Fig 2

LAB DESK FABRICATION

Getting started

As mentioned, the first step was to establish dimensions; this design should scale to many different boats with appropriate customization. In the rough sketch in *Figure 3* (not at all to scale), we can see the encapsulation of some key design requirements.

We were fortunate to have almost parallel bulkheads, which are the lines at the left and right ends of the sketch (marked by right-angles in the lower corners). There are 88 inches between these surfaces, but it had to be shortened a bit to allow installation without interference with a little rail that bounded the tops of the original cushions. I wanted to keep this for various reasons, not the least of which was minimizing surgery in case some future owner wants to restore the original configuration.

The horizontal line in the middle (with faint dotted line lost in flash glare just above) defines the split that allows this to fit through the companionway. Obviously, strength would be compromised if there were just two surfaces butted together, so we took advantage of the two laminated 3/4" plywood pieces to create a substantial ledge (1-1/2") extending from the underside of the front piece to support the rear one along the entire joint (screwed in place).

Finally, measurements from this reference line to the curved outer hull of the boat give us the shape of the distal piece, which also needs to have a vaguely-defined corner lopped off at the left rear corner to allow easy cable passage between the future console systems and the rest of the ship.

Gluing the layers

We discussed the type of plywood, judging the obvious "marine ply" overkill (at twice the price) because it's well-encapsulated. Time will tell if that was a wise decision, but we chose a nice *shop maple* at \$61/sheet from a local lumber yard ([Dunn](#)). I believe this is a birch core with maple veneer, and was very pleased with its flatness, smooth surfaces for gluing, and minimal voids.

In *Figure 4*, Fred is gluing two layers together... we wanted an overall 1-1/2" thickness to keep it from sagging, and this has turned out to be an excellent approach (it's rock solid). The adhesive is the excellent [Titebond III](#) (about \$15/quart on Amazon). He swears by this stuff, and I see why; playing with a cut-off scrap later, I found the bond stronger than the ply itself. In a later photo, you'll be able to see some of the clamping that was applied, but we really had no problems. I did ask about islands in the glue pattern without oxygen, but that's only an issue with non-permeable surfaces. Even the fine-grain maple veneer has enough internal gas space to keep any region from staying wet for long.

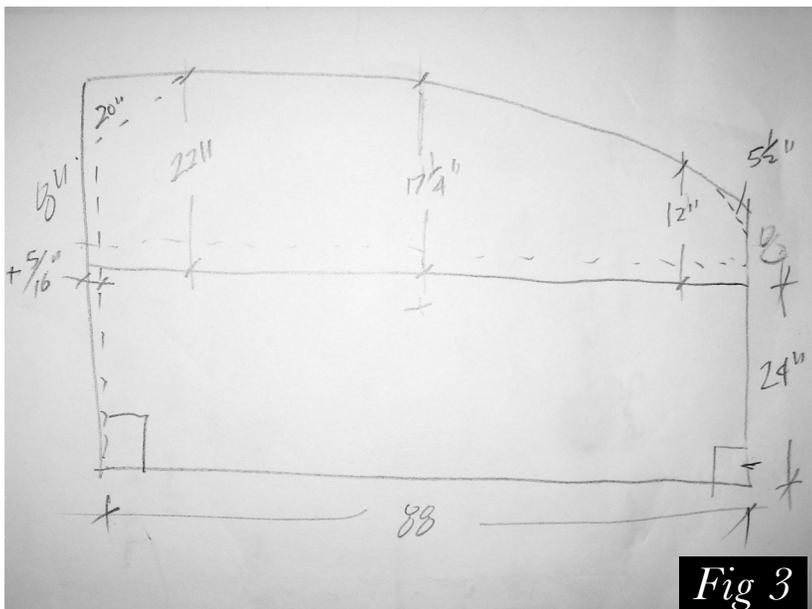


Fig 3



Fig 4

LAB DESK FABRICATION

Steel inlay

I forget who first suggested this, but early in the process I decided to add a layer of steel in the central work area of the desktop. This will let me embed magnets into various objects that need to stay put (though one fellow on Facebook pointed out that this could detune RF circuits under calibration... worth remembering). In a bouncing/tilting thing like a boat, I like the idea of keeping a few items stable... including lights, third-hand, random fixtures, and a detachable "fiddle" along the front edge.

A good dimensional reality-check is this [online steel thickness calculator](#) from my favorite magnet vendor.

The metal is a 16 x 32 inch piece of 16-gauge hot-rolled steel, \$36 from [Teeter's](#) in Seattle, and you can see it resting on the surface in *Figure 5* where Fred is using the pneumatic nailer to provide a bit more clamping pressure for the fresh glue joint. (Both sides were roughed up with 36-grit sandpaper to improve adhesion.)

He then carved away as much as possible using the router, keeping strips intact as a reference plane... then chiseled those away to create a tight nest for the steel. In *Figure 8*, he is clearly pleased with the results, with the metal nicely inset while surrounding clamps keep pressure on the glue joint.



Fig 6



Fig 7



Fig 5



Fig 8

LAB DESK FABRICATION



Fig 9



Fig 10

It was time to break out the contact cement, which would also be used to do the laminate covering the whole surface. As you can see in, it's a green can, not the familiar red one; this is Dap's "nonflammable" version instead of the "original." The difference is in the chemistry, with the green stuff being latex-based... much easier to be around than the original brain-cell-destroying explosive VOC-outgassing stuff.

Interestingly, however, most of the [Amazon reviewers](#) really hate it, and only some of them were clearly doing it wrong. This may suggest some batch variability, which is concerning, but I discussed it with Fred (who used the original formulation professionally for years), and he said the rules for this version are quite different. With the original contact cement, there was a narrow window between too wet and too dry (though you could easily refresh a layer by adding more, at the cost of additional thickness). One test was laying a piece of paper on the prepared surface; if it stuck, it was too wet; if it fell off, it was too dry. But if you apply that same rule to the latex stuff, it will always be too wet... so some experienced folks give it one test and discard it. It must be more dry before bonding.

In *Figure 9*, Fred is gooping up the steel prior to dropping it into its nest, and in the next photo you can see it solidly in place as he takes the belt sander over the whole surface to prepare it for the laminate. We did have one tricky corner (right front) where the steel didn't want to lay all the way down, perhaps due to a stray wood chip coupled with a little bit of pre-bend. We fixed that with a countersunk screw, which cinched it down nicely.

The sanding step is critical, since any little high spot can create a pesky bubble in the laminate, so that got very careful attention here. One of Fred's tricks was to glide his hand over the preassembled surface, then make waggly pencil marks on any area that needs to be finished further. Those act as an indicator during sanding, so it's easy to tell when you've covered the area (and, significantly, when you're in danger of going too far).

Once this was done, it was time to do our surface with WilsonArt D30-60 natural almond (which matches the material in the boat's headliner to give the workspace a nicely integrated look). Alas, the first 4x8 piece arrived damaged, with a big blowout right in the middle, so we paused to re-order and continue another day!



Fig 11

LAB DESK FABRICATION

Lamination

Once the new sheet arrived, we dove back in... beginning with cutting out the pieces. This is basically just making a deep groove along a straight-edge with a [carbide scoring tool](#) and then bending the whole thing until it snaps (kind of terrifying, after seeing the damaged sheet, but it went perfectly). The first part to be glued was the front edge, since we would want the top surface to overlay that before trimming.

Through all this, Fred kept up a running commentary on the process, and that's one of the things I most enjoy about working with experienced people on projects. There's nothing like a good learning curve....



Fig 13



Fig 14



Fig 12

(Throughout this discussion, I'm leaving out the redundant details of doing the same thing on both segments of the desktop... that would just be confusing.)

After we applied the edge, an easy job with nothing floppy to handle and no critical alignment issues, Fred applied local pressure with rubber and steel rollers, then zipped off the excess with his vintage 1977 Black & Decker laminate trimmer and cleaned it up with a sharp file.

And then it was time for the big piece... about which I was having grim visions involving uncontrollable sag, premature adhesion, and gunky messes. But a few months ago, while making one of countless pickup-truck loads between my old mountain of clutter and the temporary digs in La Conner, Fred had enthusiastically accepted my offer of a batch of old steel Venetian blind slats that I had been dragging around in the category of "long stuff" for decades. He said they are the best solution for keeping laminate under control while cementing, since they can keep the piece just above the surface and then be pulled out in succession without mangling the glue.

I was about to see him actually execute this magic trick...

LAB DESK FABRICATION



Fig 15



Fig 16

It was actually much less dramatic than I expected. After we flipped the cut piece upside-down and buttered both it and the substrate with contact cement, we allowed it to nearly dry (still slightly rubbery) and then went for it. The blinds were evenly spaced on the plywood surface, and while keeping a slight bow to prevent sagging, we laid the laminate on top. This gave us lots of opportunity to make sure it was aligned properly, and then, starting at the center, we simply pulled out the supporting strips ("like nuclear reactor control rods," I observed).

Once this was firmly rolled down and the edges trimmed (and the mating part completed identically), we were basically done with the shop phase of the project. We did to

a test fitting on the floor, including the row of screws at the junction ledge, then started plotting the actual installation in the boat.

This would involve three separate support structures: a robust 2x2 angle of .25" aluminum on each bulkhead, three brackets of plywood along the rear edge where it meets the hull side, and a single post of 1" stainless tubing in the middle.

Preliminary tests in the spacious setting of the shop proved that sag was not likely to be a problem... this is actually more of an issue than it would be if it was only doing tabletop duty, since it is also the substrate of the wrap-around console and we really do want it flat. It is, I am happy to observe, flat.

The next page is just a collection of photos from installation day... a little fine-tuning, wrestling the parts into place for a reality check, bolting aluminum angle to bulkheads, projecting the resulting plane to the curvy hull, mounting the rear supports after cutting them to the right angle on the table saw (*Figure 20*), and the beauty of it gradually taking shape.

In *Figure 21* you can see both side and rear supports, as well as the seam joining the two desktop sections. That is also the lopped-off corner I mentioned, which will provide clearance for cables into the boat's wiring harness.

Figure 22 shows final installation... on Facebook, that leg got a lot of comments!

LAB DESK FABRICATION



Fig 17



Fig 18



Fig 19

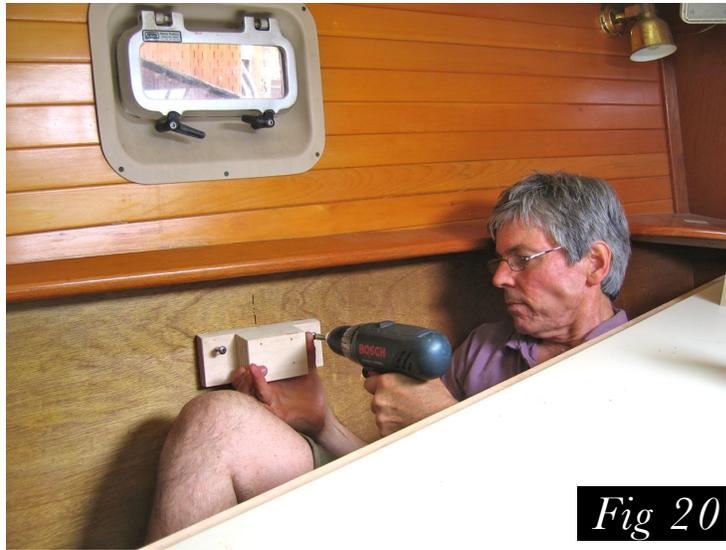


Fig 20

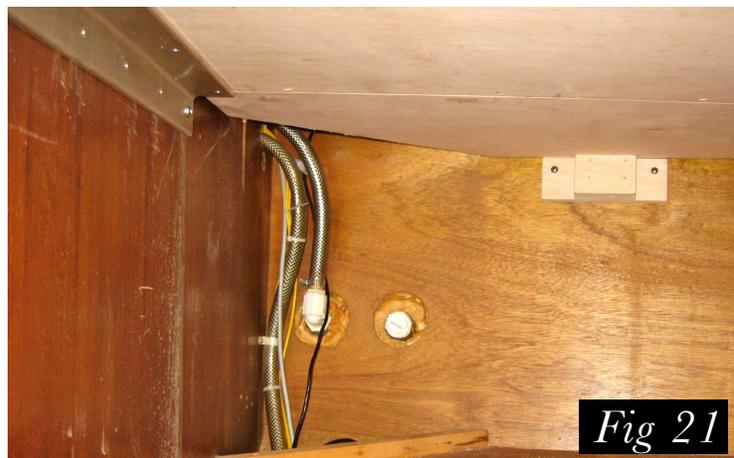


Fig 21



Fig 22

Desktop installation Nomadness was as fiddly as one might expect, given the fact that nothing on a boat is perfectly square or level... we cheated it slightly to the left to match that visible bulkhead, with the slight angular error to be hidden by the tool cabinet on the right. It went in beautifully, dead-flat and stable, and immediately improved the sense of efficient workspace in this constrained space. One last task remained... integrating a tool cabinet "wing" on the right side, against the forward bulkhead.

TOOL CABINET INTEGRATION

A place for tools

When I first bought this boat, I optimistically Tetris'd all my tools into a perfectly space-efficient little package that nestled into a drawer located under the seat of what is now the lab region. This was completely unrealistic, and I'm not sure it was ever as neat as it was in the photo accompanying my [article](#) about favorite tools:



This just doesn't work... roll-ups are a pain and they never get put away. An integrated tool cabinet was thus a key part of this lab desk specification.

It's hard to find a good tool box these days without spending big bucks (Kennedy, Snap-On), but this one isn't bad... with good drawer detents and a solid lock. There is exposed steel that will need [Corrosion-X](#) or [Boeshield](#), but for \$250 at Sears, I'll take it over their Griplatch model that felt like a beer can. We added a non-structural wing to the desktop with a bulkhead bracket and stainless support post, then fastened the cabinet down and removed the useless side handles.

And I love it... being able to put things away means I'm more likely to find them when I need them, and the location is perfect. The left edge of the tool chest is the beginning of the wrap-around console space, which I hope to be writing about Real Soon Now...



IN OTHER NEWS...

Friday Harbor!

Well, life has significantly changed! In Issue 19 (May) I spoke of the new digs, and the main reason there was no June issue is that most of my time was spent schlepping tonnage... endlessly fascinating, but not the kind of material that makes for gripping tales.

It took four loads with my Dodge RAM pickup and 24-foot trailer (at \$297 each for the ferry round-trip), along with a few more by truck alone (\$57 each)... but I am now fully out of the old place in La Conner. A yacht broker there was desperate to occupy my slip the moment the lease ended, so on July 1, with Al Felker aboard, I cast off the docklines to relocate to the marina north of town via the fuel dock. The latter was timed well for once; I caught it on the dip at \$3.23 and topped off all three tanks (156 gallons added, for a total of 230).

One problem, though... the boat was a pig, barely able to maintain steerage in the current and taking forever to turn. The clincher was seeing a cloud of black smoke at anything much over 1200 RPM... obviously a fouled prop.

After getting settled at the guest dock (oddly exciting after 1.5 years in the same spot), I hired Travis Crabb to give her a much-needed once-over.



Temporary Chart Plotter Mounting

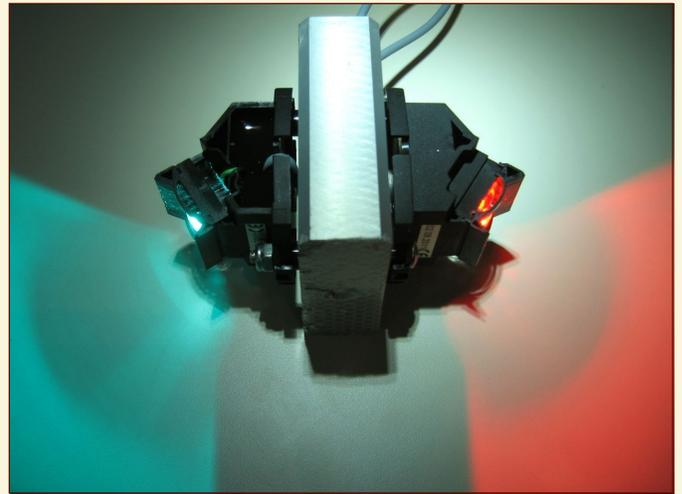
I mentioned recently that I acquired a [Raymarine E7](#) multifunction display... which has the distinction of letting one use an iPad as a remote (free to view, \$40 to be interactive). It's a sweet little rig, though I simply can't forgive them for using a neodymium magnet to hold the little micro-SD chart door closed, resulting in a 27.5" compass-safe distance! Not like people might want to mount this on their steering pedestal or anything... Other than that, I love it, and prompted by the move from La Conner to Friday Harbor I cobbled a quick temporary mount next to the companionway, using a recycled stanchion with a Sea Dog 290904 split rail fitting at the other end. It worked beautifully in the nasty weather we had for the delivery.



ARRIVAL IN THE SAN JUANS

The Delivery Voyage

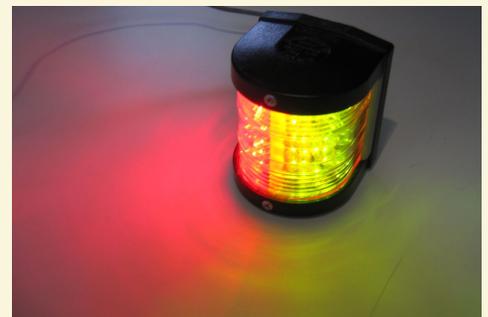
Once tanked, cleaned, and blessed with a Vessel Safety Check by the USCG Auxiliary, there was no reason to hang around the marina at \$44 a day... not to mention the matter of crew-availability timing. My old sailing buddy Dave Robb (photo below) joined me for the jaunt on July 3, and in an eerie replay of previous *Nomadness*-relocation expeditions it ended up being truly stinky weather. We motored grimly out of the channel before the dreaded keel-sucking -3 tide, scooted out Guemes with the ebb, then crossed Rosario to share Thatcher Pass with a ferry in heavy rain and squally gusts. The new chart plotter was a wonderful addition, much better than scampering up and down to squint at a delicate laptop running nav software.



Bow LED Navigation Light replacement

Way back in 2009, I replaced the boat's power-hog incandescent bicolor with Aqua-Signal Series 32 LED units. I was immediately annoyed by the mounting system, but they worked well and I didn't think much about them... until the green one died this year at the dock. Water incursion and freeze/thaw cycles had fractured the lens, and the company was kind enough to replace it with their new Series 33 (and take the old one for analysis). So far, I like these much better... there are two actual mounting holes now in addition to the one for wire, and an afternoon of surgery to my homebrew aluminum mounting block, along with some awkward soldering whilst hanging over the pulpit at the guest dock, lit me up enough to feel good about heading for the island.

*My first LED navlights for boats were homebrew in 1992 for the *Microship* project (photo at right), and I tried to get the industry interested. Nobody thought it was a very good idea, which makes sense given the quality of the available emitters of the epoch. That green really was as sickly yellow as it looks!*



ARRIVAL IN THE SAN JUANS

Other than the grim conditions, it was a rather swift journey of about 5 hours... though I was disappointed after we rounded Lopez and headed south in Upright Channel to discover that the autopilot could not hold the course in the stiff headwind and had to be hand-steered. To be fair, the newish Simrad AP24 has never had a proper on-water commissioning procedure, so I guess there's something else for the [bulging to-do list](#).

This was Isabelle's first experience with the boat getting off the dock, and she spent the first half of the adventure deeply-buried in some uncomfortable corner underneath the old settee. At last she ventured out and looked

around, then seemed to accept her endlessly changing fate.

As we approached Friday Harbor, I was worried about the unfamiliar landing... threading around the imposing dolphins associated with the ferry terminal and dealing with the wind. But the spot is well-sheltered from southerlies and in response to a phone call, dock angels Kurt and Trevor materialized; before I knew it, they strolled out to casually catch our lines.

And just like that, *Nomadness* was safe in her new home port.

In the photo below, 9 days later, she's already showing live-aboard clutter: a Gary Fisher Wahoo bicycle for the commute between boat and lab, deck spaghetti awaiting a Woolite soak,

kitty in the window, and kayaks. This is a great place for little pedal/paddle jaunts, and we recently discovered Turn Island (a little gem with tricky currents and rips, but a microcosm of the San Juan Islands ecosystem).

I've rigged the spare halyard to haul my big yellow Hobie i12s inflatable over the lifelines, and galumphing aboard from the swim step is easy. But Kirsten's Necky Manitou is tipper on entry and exit, so she uses the stern platform of the neighboring derelict *Yukon Jack*. I've decided the name is an acronym:

"Yo, uncoordinated kayakers on Nomadness! Jump aboard carefully, 'kay?"



COMING ATTRACTIONS

Epic Power Project

One of the more vague and complex categories in the to-do list has always involved power systems... since that is a subject with many levels of granularity. The new solar array (and its physical substrate), replacement of mysterious old cruff with a more streamlined toolset for battery management, elimination of some undocumented legacy stuff, updated distribution system, monitoring tools... there's a lot to it.

One important job was done recently... removal and bypassing of an ancient shore-power change-over relay that became completely redundant with modern inverter chargers (not only the one I didn't like that came with the boat, but the new Outback as well). It was one of those things I simply dreaded, combining a critical and deadly resource (shore power) with extremely awkward back-breaking physical access.

But Al Felker spent a few hours on the boat one evening before I left La Conner, excising the demon and taking one important step toward increased simplicity.



Things are about to change a lot more in the power domain; my old friend [Tim Nolan](#) will spend about half of August aboard, working with me on the rest of this system. It's too early to tell exactly what will get done, but his productivity is legendary and I'm sure I'll have a lot to report in the next issue.

The existing DC distribution system (circuit breaker panels and everything that hangs off of them) works fine, but has a lot of old stuff that goes nowhere... and the AC panel is in an awkward location where I'd really rather have a pantry for galley stores. Those two worlds are about to merge into a whole new power console; the [Blue Sea](#) breaker panels are now both in stock, along with related AC and DC multimeters and other hardware. In the photo above, you can see how the old power console lifted up for service to expose the barrier strips on the back wall; unfortunately, this also makes the panels themselves extremely uncomfortable to access.

The new console will hinge down and then out at the lower left corner (somehow), nesting against the helm console to allow access to both regions. All the power stuff will be in one place, finally, with current documentation, status indicators, and even a dedicated network node to report the status of all the breakers and log any detectable error conditions (I say that with deliberate vagueness, since I'm not really sure what those are... but having a micro here will allow remote observation of current and historical distribution status).

This is just a couple of combined stock photos from the manufacturer, but is a preview of the upcoming breaker panel. Joining it on the console will be genset control, AC metering, the MATE control unit for the Outback inverter-charger and solar controller, an LCD for the node, and a few related LEDs for things like ACR status and a remote view of the Balmar engine charge controller.

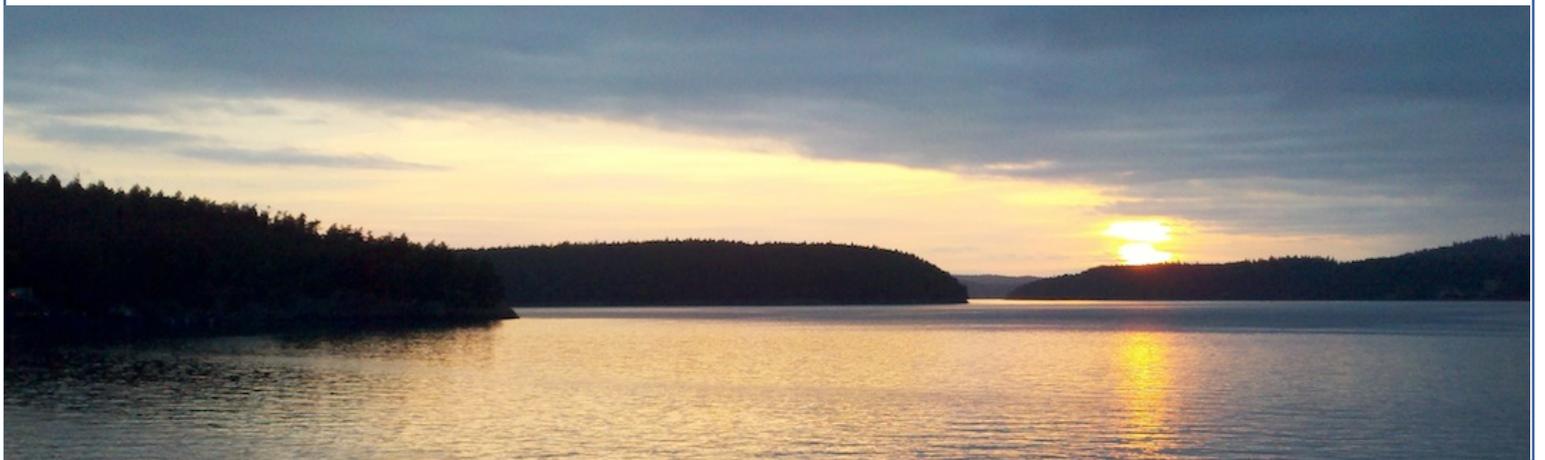


Finally, a sneak preview of the new solar array; this is Derek, doing a test fit of the frame structures:



JULY, 2012

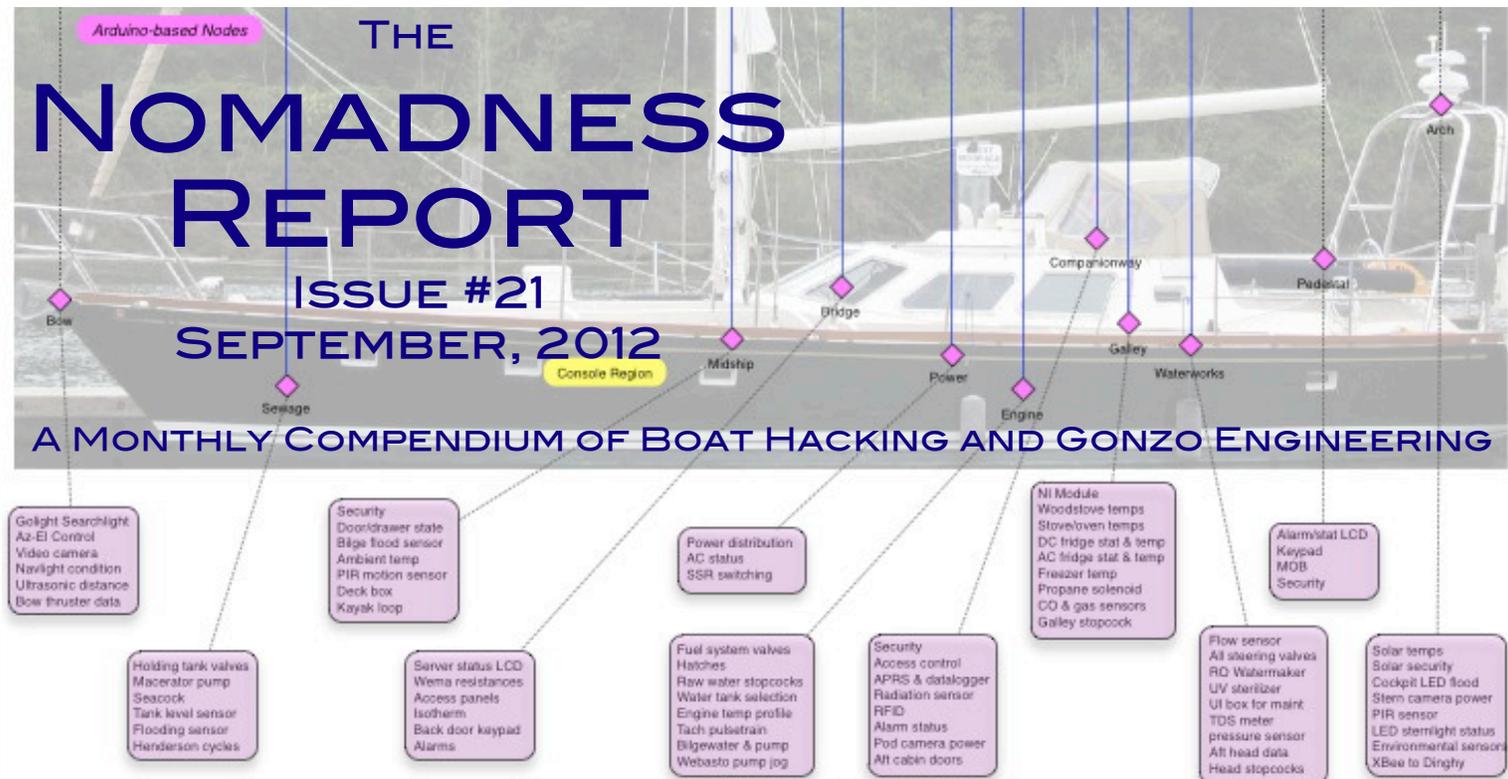
ONWARD!



THE NOMADNESS REPORT

ISSUE #21
SEPTEMBER, 2012

A MONTHLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



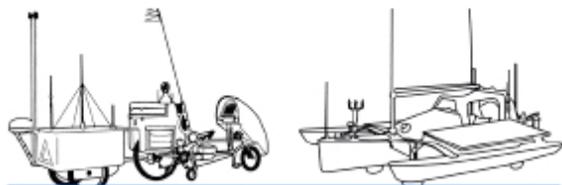
GEEK'S VACATION PROGRAM

Yikes, talk about diving in! The new facilities are still not fully set up (with about 50% of the space consisting of an undifferentiated mountain of boxes), but a number of projects are well underway. This has been accelerated by the return of one of my favorite things... *Geek's Vacations*. With on-water digs in Friday Harbor, this might even become a core part of the project as it was back in the Microship era; two have happened since our last issue, both yielding significant progress.

Meanwhile, before it gets too cold, *Nomadness* needs a haulout. Bottom paint is tired, there is a broken rudder bearing, and the chart plotter with integral sounder needs a transducer. It looks like this will be taking place at Cap Sante in Anacortes... and one last trailer run is looming to bring the Microship over from the old lab on Camano Island.

The past few weeks have been filled with cabling and console projects, extraction of long-dormant wire, a major upgrade to the power distribution system, and refinement of live-aboard tools. This issue covers a wide range of topics (and is published on my 60th birthday)... enjoy!

-- Steve



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The photo above dates from 1974, when I was working on my first homebrew computer (8008). A Hammarlund SP-600 receiver and Tektronix 531 scope are on the desk behind me.

GEEK'S VACATIONS

One of the most stimulating parts of my technomadic projects over the years has been the involvement of interesting people. Over-the-top gizmological undertakings attract *übergeeks*... and I've been fortunate since the '80s to have help from people who know more than I do about all sorts of subjects.

This was a daily routine in the bikelab epoch, based at Sun Microsystems in Silicon Valley, but when I moved to the woods 50 miles north of Seattle it was a little harder. Too remote for drop-in techies, it soon became clear that it would have to be more of an "event." Thus the *Geek's Vacation* program was born... friends from afar would come visit for a week, get fed and housed, play tourist a bit, and join me in a project. [Tim Nolan](#), in the upper photo, was one of the stars... building the Microship solar charge manager and power control system.

It's more inviting now that I'm based in Friday Harbor: come help with a project, hang out in a tourist destination, maybe see some whales, and go for a sail! Tim returned a few weeks ago to help install the first solar array and do some much-needed power-system fine-tuning, and after a short break to catch up on my slothful lifestyle, I was joined by [Daniel Collins](#) for a week. We got the single-sideband rig fired up, including PACTOR data communications. Good times, both, and lots of stuff has been marked off the project list.

So this is an invitation to my subscribers... most of y'all are pretty interesting people, and if you'd like to participate in this project while spending a few days aboard *Nomadness* in a Pacific Northwest paradise (including some time on water), please let me know!

And now, tales of the two Geek's Vacations...



FORWARD SOLAR ARRAY

Recent issues have revealed bits of the solar support structure, and you may recall seeing photos of the stainless arch interface and tubular frame fabricated by Derek Peterson. Tim and I decided to get the first array installed (180 of the eventual 420 watts).

Our task was to bond six of my Solarex 30-watt Ultralite modules onto the substrate, bus them into a series-parallel configuration, then wrestle it into place on the boat. In the photo below, you can see notches on the sides to clear the backstays... along with an oversize metal border that provides mounting space for antennas and cockpit lighting. This has already come in handy... the aft corners

now carry a dual-band J-pole antenna for the Kenwood D710A radio, and a 2-meter stainless antenna dedicated to a stand-alone APRS tracker.

The tan fabric under the boom is a sort of floppy bimini that came with the boat; it zips to the trailing edge of the dodger and ties somewhat clumsily to the arch. This will go away, with the new solar structure providing a starting point for a more robust cockpit enclosure... but at the moment it is a very valuable sun shade (although it flaps crazily when the wind kicks up). The distant edge of the solar panel is supported by the radar arch, which also carries the cabling.

These photovoltaic modules were custom-made long ago by Solarex for the Microship project, and consist of a Tedlar-encapsulated sandwich with no metal backing... so fragile that you can't even pick one up without shattering it. At the time, this made sense, though the array we built then ended up being a heavy (and hot) foam-core sandwich that was not very practical. Those were not recoverable, but I had enough on the shelf for this project... so even though there are newer and higher-performance modules available now, I decided to use them. Time will tell if this savings was worth the substantial substrate fabrication project!



FORWARD SOLAR ARRAY

We did a lot of agonizing over what kind of adhesive to use, knowing that the plastic and stainless mating faces are not only extremely smooth but likely to have differing coefficients of thermal expansion. I've recently done battle with this problem on the seemingly endless curtain-magnet problem (the epoxy shown in Issue #19 has failed... see page 13), and the canonical best solution in these cases is expensive: 3M VHB (Very High Bond) tape. For the solar panels, I would need the fancy hi-temp stuff that can take -31° to $+300^{\circ}$ F, so I took a deep breath and spent \$50 on a 36-yard roll of #4646 half-inch tape, .025" thick (McMaster-Carr 7201A51).



Before bonding, however, we had to make holes for the wires emerging from the backs of the modules, and since these had been custom-made, they weren't quite as uniform as expected. Wire exits included a silicone fillet, so I fired up Cecil the milling machine for the first time and drilled a set of 3/4" holes in the stainless sheet. The trick here was to run the drill as slowly as possible and keep up a high downfeed pressure; otherwise, stainless tends to work-harden and get hot.

The tape application pattern is full perimeter along with a single strip down the center. I debated about leaving a little gaposis for outgassing, then imagined it being an ingress point for water that will freeze and decided against it... I might even double down on that conclusion with a surrounding fillet of sealant, since I probably left unintended gaps anyway. This is a very inexact science, something that always drives me a little crazy.

One of the puzzles that Tim and I spent quite a bit of time discussing was the array configuration... what series-parallel combination would let us minimize both I^2R loss and partial-shading effects? It turns out that 14 modules can only be factored into 14X1 or 7X2, so we decided on the latter, running it at 24 volts (about 40 volts open-circuit). This 6-module assembly would thus be wired as three parallel sets of two in series.

This is important, since higher voltage allows lower current, which translates into smaller cable size... not only cheaper but easier to pull through the arch tubing. After running the numbers, it appeared that we could get away with two runs of 10/2 cable, one for each array, so I bought a 100' roll from [Genuinedealz](#) (less expensive than the standard marine suppliers... it doesn't always have to be Ancor, you know!). I also picked up high-temp wire tie anchors to provide support for the bussing on the underside of the stainless panel.



FORWARD SOLAR ARRAY



Once the modules were bonded in place, it was time for the cabling... I slumped at the desk to rest my back while Tim took over with ratchet crimper and heat gun. The wire provided by Solarex is wonderful (Tim says it's called "robot wire" due to its excellent flexibility), and the bundle he's bussing in the photo above finds its way out to the arch, where it is spliced to one of the jacketed #10 cable runs.

From there, it heads to a little wood panel with one 20A circuit breaker for each array (see page 11). Still separate, these switched cables then make their way to the Outback MX60 solar charge controller, which maximizes the power point and pushes combined current into the batteries via #6 wire and dedicated 60A breaker and shunt (with an Ethernet connection to the other Outback power equipment to allow centralized monitoring and control).

But first things first. We now had a big heavy solar panel with dangling wires, and that had to be attached to *Nomadness*. Things were about to get physically difficult (though the larger aft panel, hanging out over the stern, will be even worse).

Derek had fabricated a couple of support struts, with mating tabs to modified split collars on the bottom end and a stack of half-inch nuts welded into the top end (a proper coupler nut with fine thread would have been nice, but we could not find one locally in stainless).

I chased these with a tap to work out the rather substantial thermal distortion from welding, added stainless rod-ends (McMaster 2434K25 at about \$20 each), and then, with Tim holding everything level, pinned them to temporary chunks of wood that will be replaced by stainless now that we actually have something to measure. Nothing on a boat is ever parallel, square, or the same on both port and starboard sides... that's part of their charm, I suppose, but it can turn fabrication projects into hair-pulling challenges.

The resulting structure is triangulated by this, the panel, and the arch... and it's surprisingly stiff. And in the month since it was installed, hot summer sun has not caused any apparent problems with the bonding method. Encouraging so far, and I should finally get a chance to generate some free power.

POWER SYSTEM REFINEMENTS

Tim's geek vacation also yielded some other much-needed changes to the Nomadness power system. Looking at the relevant section of the [To-Do List](#), we decided to focus on battery-management and shore-power issues.

Much of this was in the category of cruft-elimination, and there is now a small mountain of extracted wire in the lab along with a few eBayables... including a triple battery isolator formerly used for the alternator, a smaller two-bank unit that once took care of a solar panel, and a galvanic isolator that was used to control stray-current corrosion. Holler if you need any of this!

We didn't change the business end of the engine-charging system (a vintage Lestek 130-amp alternator and a Balmar 4-stage regulator), but eliminated that downstream battery isolator I mentioned which allows charge current to flow to multiple banks while preventing them from discharging to each other. The cool kids these days are using a new device called an [Automatic Charging Relay \(ACR\)](#). These notice when charging is happening and connect battery banks together without diode losses... then keeps them that way until the state of charge drops far enough (about 10%) that isolation is needed to allow such niceties as later engine-starting.

While doing all this, we were hauling out old dead-end cables, discovering lots of naughty things like loads connected directly to the 690 amp-hour house bank (some without fuses, each a potential harness-melter or boat-destroyer). Every exorcised no-no added to the clarity and safety of the system, and the new drawing is much less confusing. This is all stuff I've wanted to do for ages, but I often need a strong nudge to start tearing apart things that work and are hard to reach.

The final task was installing a [Charles ISO-G2](#) isolation transformer, which completely severs all direct

connections between shore power/ground systems and those aboard the boat. This protects the hull from induced corrosion (which can be severe) and prevents delicate humans from providing a return path to shore through their bodies. All metal boats should do this, and I've been hauling this 60-pound monster around for a couple of years without hooking



Redneck Fork Terminals

One of the things we were happy to get rid of was an old Kraus & Naimer AC source selector switch, mounted in a painfully unserviceable location. Once before I had a shore-power cable just fall out of this thing and fixed it with a mirror, but I didn't look closely enough at the time to see how it had been assembled. Given that this carries up to 30 Amps of AC, the method used here is NOT something I'd recommend. A local boating friend calls this switch a "fire-starter," and skipping proper cable termination makes it even worse... close-up, the wires at left show deep discoloration from having run very hot. Please don't ever do this.

it up... largely because the AC side of my power system was such a mess. Now it is in place, and ground-isolation measurements are in the multiple-megohm range. In this photo, Tim is making jumpers to parallel windings to configure the transformer for 120-volt operation (it also handles 240), with Isabelle doing quality-control checks on his crimping job.

The big problem was audible hum, with it bolted to the plywood floor of the power bay. I fixed this by raising it onto four vibration-damping rubber sandwich mounts with 3/8" studs on both ends, about \$10 each from McMaster-Carr (5823K21). Now I don't notice any sound at all.

I have also had one apparent instance of a collapsing inductive field popping an LED on the shore breaker panel. [Blue Sea](#) generously sent me some spares... we'll see if that phenomenon is repeatable.

SSB RADIO INSTALLATION



Daniel Collins

I met Daniel online last year and we struck up an enthusiastic correspondence... he was highly conversant with NMEA2000 networks, and preparing his boat, Aletheia, for adventure. He got a bit more than he bargained for... first a very nasty storm in the Gulf of Mexico, then a dismasting and subsequent tow into Charleston after failure of a titanium tang. He's exploring retrofitting a junk rig on the Allied Princess, but is first taking a travel break... and I was happy to be part of that.

I've been a ham radio operator for most of my life, starting as a Novice at about age 12 (WN4KSW), lapsing for a while when "the computer hobby" was completely immersive, picking up a Tech call while in Ohio (KA8OVA), then upgrading to General and becoming N4RVE about 20 years ago when I had a base office in North Carolina. Now I'm studying for a long-overdue upgrade to Extra (dang, some of that stuff is hard!).

I consider this an essential part of the technomadic life, even with pervasive tools like cellular phones and Internet. Why put all your trust in communication modalities that depend on corporate infrastructures when they may be out of range, too expensive, or even disabled when you need them most? Besides, radio is fun: a ragchew on 20 meters is a very different kind of pleasure than even the most erudite Facebook thread... not necessarily *better*, just markedly different (and kind of miraculous, when you think about what's really going on).

Over my years of bicycling, I carried a variety of VHF and UHF rigs, allowing use of repeaters as well as easy chat with traveling companions. But the HF gear was the most fun, ranging from QRP (power under 5 watts) on the *Winnebiko II* to a rather <cough> excessive communications bay on *BEHEMOTH* that included HF, ATV, tuner, audio filtering, and multimode 2m/70cm rigs with preamps for satellite use... see photo below.

(Yes, I went through a phase of operating [OSCAR-13](#), the late lamented poor-man's geosynchronous bird... a Molniya orbit with a long hang time during apogee to simplify tracking. With a pair of KLM crossed-yagi antennas clamped to the yellow pole on the back of the trailer and manual tweaking for Doppler, I managed quite a few QSOs with hams around the world...)

So naturally, with a proper console space in this much larger nautical substrate, a decent single-sideband radio is a must... along with the tools to use it for email and other digital modes. Daniel was kind enough to spend a week helping with the installation, and it's good to be back on the air!



SSB RADIO INSTALLATION

This system will be one of the first drawings as I get back to work on documentation projects, and I have just set up an on-board iMac with OmniGraffle and the 11x17 printer. The gritty tech details will follow in a later issue; this article is more about the physical installation and overall capability.

Like so many projects that have been in the planning stages for a long time, all this has been sitting on the shelf for about 3 years. That translates into not having the latest version of the expensive [PACTOR](#) box, but otherwise the hardware is current... the Icom [IC-M802](#) marine SSB rig and matching AT-140 antenna tuner are the same units I would choose if purchasing the rig today.

Daniel's visit was initially a dilemma; he's such a clever chap that we had trouble deciding what project should occupy our week together! I had been assuming that it would involve the NMEA2000 network since he knows that stuff well and we'd already spent a fair bit of time on the phone chatting about design decisions... but the agility of youth trumped puzzles that could be addressed via email. I've been wanting to be back on the air with an HF radio for years, and the installation on the boat would involve a fair bit of crawling into awkward spaces. Since he is also a radio geek, the choice was clear.

The radio itself consists of two pieces: a display unit that will be mounted in the comm console, and a "black box" that is the transceiver itself (as well as connection point for much of the cabling). With little fanfare, I bolted this to the bulkhead under the desk, where it can have more cooling airflow than it would have inside the enclosure.

This was not the physically awkward part, though. Daniel immediately jumped into that... installing the tuner on a bulkhead inside the hydraulics bay at the stern, then running the GTO-15 feed line through a handy bit of gaposis into the lazarette, and thence to a

clamping assembly at the bottom of the insulated backstay. The tuner matches this "random wire" to whatever frequency the radio is using, thus minimizing reflected power and keeping the RF energy outside of the boat (we hope!).

This is only half the antenna system, though. The part that can be tricky is the ground, which is what this "pushes against." Folks with fiberglass boats try to couple to seawater with methods ranging from bonding on-board metals or glassed-in copper screen to commercial products like sintered-stainless blocks or the popular [KISS-SSB](#).

In my case, the steel hull eliminates the need to do anything fancy... except for one little detail. Connecting the tuner to the hull would not only provide an excellent RF ground, but also create a DC ground loop that can drive galvanic corrosion. There needs to be a capacitor in there, transparent to the radio signal but opaque to direct current.

Lots of folks use disc capacitors, but they feel too fragile to me in this environment... so I talked to a few old-timers and went eBay shopping. This beautiful 1943 high-voltage mica capacitor from a Navy ship is just the ticket:



Daniel did some metal prep to make a good connection and then bolted this to a hull rib... connecting it to the tuner via fat copper foil. This maximizes the ground current at these frequencies due to the *skin effect*, providing much greater conductivity than a piece of wire.

All this was done while wrapped awkwardly around a corner, and there was much grunting back there... but he emerged victorious. We spent a few hours stringing the two cables forward to the radio (tuner control and heavy coax), then turned our attention to power.

Radios like this need a solid battery connection, and should not be powered through a standard breaker panel. Here I was lucky... one of the many pieces of *cruff* slated to be removed from the boat is a LectraSan sewage-processing system, and it had a dedicated run of 4 AWG cable connected to a stand-alone 50-amp magnetic circuit breaker. I re-routed it to the lab, and... the length was perfect.

Knowing that other radios would also need this beefy connection, we added a Blue Sea 6-circuit covered [fuse block](#) to the bulkhead in the "black box region." (I was tempted to use a [RIGrunner](#) with its Anderson PowerPole connectors... but I have no desire to plug and unplug these rigs very often.)

With the Icom rig cabled to the fuse block, all that remained was the connection between that and its panel, the speaker, a ground, and a few cables to bring the PACTOR modem into the picture. Fortunately, I had bought the whole package as a kit from [Dockside Radio](#), including the modem, so it was all pretty much plug-and-play at this end. Once I have a proper drawing done, I'll write a follow-up to this article with much more technical detail.

And it worked! Since then, I've chatted with a dozen states as well as Japan and Brazil, as well as set up a WINLINK email account, running under VirtualBox emulation on the MacBook Air. The Air is now on the air... see photo on page 2.

THE ANTENNA FARM



This is Daniel, working on the run of GTO-15 feed line to the backstay. This cable has near-mythic qualities in the sailing community, but is nothing special... just fat stuff with enough insulation to minimize your chances of getting an RF burn. The GTO stands for Gas Tube and Oil burner, and the 15 refers to 15kV of dielectric strength.

The connection is a bronze GTO BUG that makes an electrical connection to the backstay, and bits of plastic tubing are being used as stand-offs. After the photo was taken, we found a little slack and added an "inverse drip loop" to reduce wicking.

The bottom photo is the antenna farm sprouting from the arch and solar panel. From left-to-right:



- ☼ Shakespeare 5250-HAM half-wave for APRS tracker on 144.39
- ☼ VHF antenna dedicated to Vesper AIS, along with GPS receiver for same
- ☼ The backstay for Icom 802 HF (angled white sleeve, insulated down low for safety)
- ☼ Open-array 48-mile radar
- ☼ Shakespeare 5410-XT for dual-band cellular Internet (via Cyfre amp to Novatel U760 in the Cradlepoint router)
- ☼ Rocky Mountain dual-band stainless J-pole for Kenwood D710A.

The main VHF whip is on the masthead. As soon as the aft solar array is in, I'll add the Rogue Wave WiFi and Sirius satellite antenna (unless I figure out how to mount it over the pilothouse, which would be a shorter cable run), and somewhere around there will be the NAVTEX dome.

CONSOLE DIRECTORY - A TEASER

NOMADNESS CONSOLES & ENCLOSURES

Name	Location	Functionality
Inside Helm Console	Pilothouse, starboard side below window facing forward	Navigation and piloting: steering, autopilot head, marine VHF, AIS, instruments, N2K display, nav Mac screen, Yanmar engine control panel, throttle and shift levers, Radar, tank monitors, diesel furnace thermostat
Power Console	To right of helm console at same operating position	All AC and DC circuit breakers, inverter/charger and battery monitor panels, all power metering, ACR, engine charger display, nearby battery switching. (Original AC console is becoming a pantry.)
Nav Computer Bay	Small panel adjacent to power console on pilothouse tabletop	Dedicated Mac Mini for navigation and ship operations (light lists, charting, logging, documentation library, etc.) Owns Planar daylight LCD at helm; panel supports random overflow devices relevant to this region.
Internet Alcove	Console space over nav desk	Router and network hubs, cellular amp, Mini server, laser printer, other peripherals, swing-arm monitor, WiSpy spectrum analyzer
Zone of Hackage	Under top layer of nav desktop	Primary tinkering environment, USB hub for nodes, crosspoint matrix, data collection tools, security, watch, speech I/O, back door, always-on monitor
Audio Console	12U Rackspace, angled to left side on lab desktop next to iMac 27	Audio production tools: Edirol M16DX mixer, Tascam DP-008 Portastudio, Fusion iPod stereo head with Sirius, speaker switching, audio amp, phaser, rack synth (maybe), compressor/expander
Communications Console	12U Rackspace, centered on desktop at primary operating position	Communications tools: Icom 802 SSB, speaker, PACTOR, 706mkIIg, RigBlaster Advantage, Wavenode SWR/Power monitor, Kenwood D710 dual-bander, SDR, backup basic marine VHF, NAVTEX display
Lab Console	12U Rackspace, angled to right side on lab desktop next to tool cabinet	Lab and Infrastructure tools: Digital oscilloscope, DMM, bench power supply, networked AC distribution and standard outlets, utility connectors (DC, Ethernet, USB, N2K), local node, breakers
Battery Alcove	Shelf with safe, next to wall-mount LCD TV	AC and DC distribution for all battery chargers: Li-Ion cells, drop-in handheld radios, personal electronics, Makita, etc. This doubles as a standing workbench with good lighting and multiple power sources.

A POTPOURRI OF UPDATES

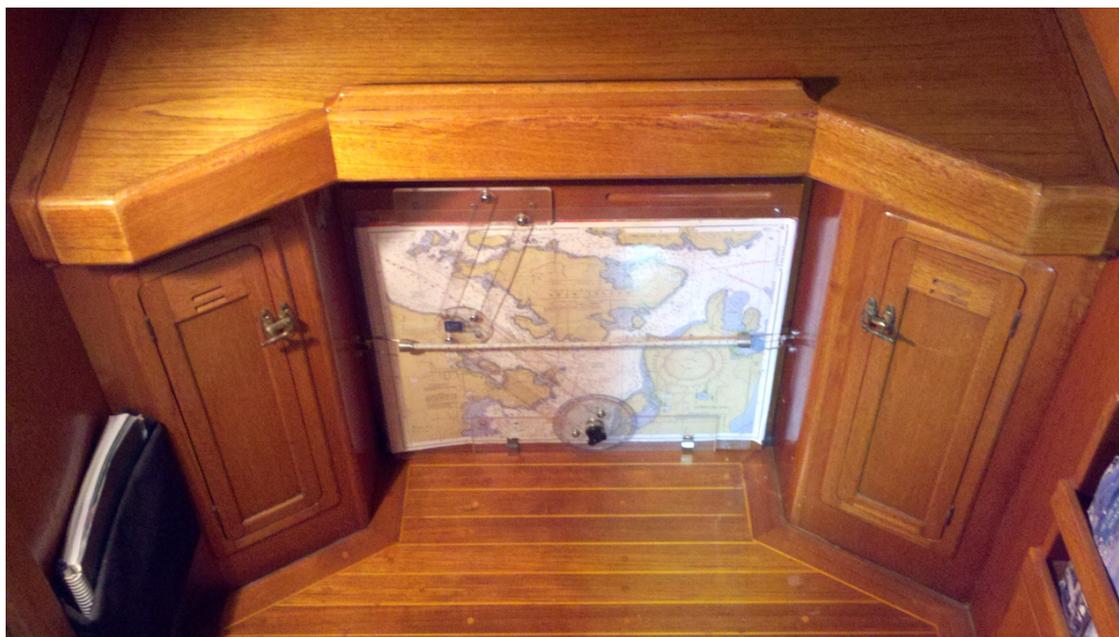


Bow Thruster Alternatives

I continue to keep my eye open for any shortcut to the maneuverability challenge; a recent ['Lectronic Latitude](#) posting suggests an interesting solution. Seriously, I did look into an externally mounted unit called [Exturn](#) that intrigues me, though it would still be prohibitively expensive on my current budget. I remain fond of my deployable "Redneck Bow Thruster" design concept, but it will be a while before I can get to it. So no news, really; this is just an excuse to run the above photo.

This is the little breaker panel for the two solar arrays that I made after wasting way too much time trying to find something off-the-shelf. It's wonderful to have a milling machine again... cranking X and Y axes after doing a drawing puts the bit right where you want it, instead of marking up the part with pencil and center punch, then trying to keep it all steady on the drill press.

I used an end mill to remove 1/8" of thickness on the backside where the breaker bodies go, since they expect an aluminum panel (I could have brought those collars flush, but at this point I was getting nervous about making it too thin and seeing a chip follow the grain through to the pretty side). This assembly goes over a closet in the aft cabin, and the 10/2 cables from fore and aft 24-volt solar arrays pass through these 20A breakers on their way to the charge controller. From there, it's a run of #6 to battery via 60A breaker and shunt....



Speaking of wood bits, here's a quick sneak preview of the future home of the *Zone of Hackage*. That lid lifts in two stages, the first exposes a beautiful space about 2" deep that will be filled with circuit boards and the always-on server, and then all that lifts to expose the top-loading freezer. Not sure whether the latter will be useful cooling or a condensation problem, but I'll monitor airflow closely in any case. The Chartkit Plotter has a new home as well, where it fits perfectly and looks rather cool.

TOOLS AND TRICKS



Fluke Instruments

The venerable model 87 digital multimeter (left) has been in my tool kit for 20 years, and its reliability has led me to select other Fluke instruments as needs have arisen. The clamp-on ammeter and IR thermometer came next, and a few months ago I added that little AC probe for checking circuits before you touch them.

But the most useful thing lately has been the [IntelliTone](#) cable tracer on the right (receiver and transmitter). I've removed a formidable pile of copper, loosening the wire harnesses significantly, and this device has been invaluable. Using it is a bit of an art form (RF and capacitive coupling are involved, after all), but it is worth the learning curve. It comes with clip leads as well as network connectors, and has become an essential part of my cable-sleuthing tool kit.



LED Work Light

For the past few months, I have been risking arcs and worse by using one of those cheap aluminum clamp-on work lights from the hardware store. It's hot, ugly, conductive, and requires AC... really not a good tool for a boat.

Agess ago, I bought what was then a high-tech Hella LED spreader light... then left it in a drawer for four years. There are much better ones now (the Rigid Dually M-Series comes to mind), so this was on my list of things to sell... until I realized it would make an excellent work light.

I added a cigarette lighter plug and a stray spring clamp that happened to be lying around, and now have a reasonably cool and bright light source when I'm head-down behind a console.

Aromatic Leak Detector

One maddening problem that plagued me for <cough> years is leakage around the wood stove smoke head... it had been cracked by over-tightening mounting screws on the curved deck, and the Dolphinite didn't play nice with primer that was not sealing the wood. I've since re-bedded this (with 4200), and finding the problem involved red food coloring applied on a

rainy day... effective, but it stained my Treadmaster. But when we had our first rain in 2 months last week, water poured into the boat... at first I feared that I had only made the problem worse. I couldn't find the dye, but used something better... [almond extract](#)! The alcohol is soluble in water, and drips aromatically revealed their source: failed sealing around the forward pilothouse window. Emergency silicone...



CURRENT PROJECTS

Console Racks

Waaaay back in Issue #15, I wrote at length about the planned console system, comparing off-the-shelf rack frames from various vendors and even toying with the idea of rolling my own using 1" square steel tubing. This puzzle has continued to be the focus of much Googlage, and I recently started talking with vendors of the [Middle Atlantic](#) product line. As before, I homed in on the CFR series racks, and after a flurry of inquiries, made friends with the folks at [Markertek](#)... likely becoming a reseller, should you happen to need rack consoles or A/V systems for your boat.

Anyway, three CFR-12-16 units are now on order, along with a couple of blank panels for the communications console, some cable-management accessories, hardware, and a few pass-through connectors for ethernet, USB, and other handy things.

I'll elaborate on the design in the next issue, but it has become very simple... matching the height of the tool cabinet and all sliding under one smooth "roof." This is going to be fun... stay tuned!



Really, Really Last Word on Curtain Magnets. I Hope.

Throughout the history of this publication, I have been mentioning the pilothouse curtains that are cleverly held on with magnets sewn into the fabric and bonded to the window frames. Only... the adhesives have been driving me crazy.

Two flavors of cheap double-stick foam tape failed (one by slowly creeping, the other by falling off), and I had no luck with Gorilla Glue. I finally made a load of aluminum brackets, sanded the magnets, and used epoxy. That failed too... when hot sun makes a greenhouse between glass and curtain, the differing coefficients of thermal expansion pop the bond, with the magnet surface left clean. Obviously this calls for better surface prep, but post-mortem analysis of the rubbery epoxy did not impress me. But remember that VHB tape I mentioned on page 4, which Tim and I used to affix the solar modules to the stainless substrates?

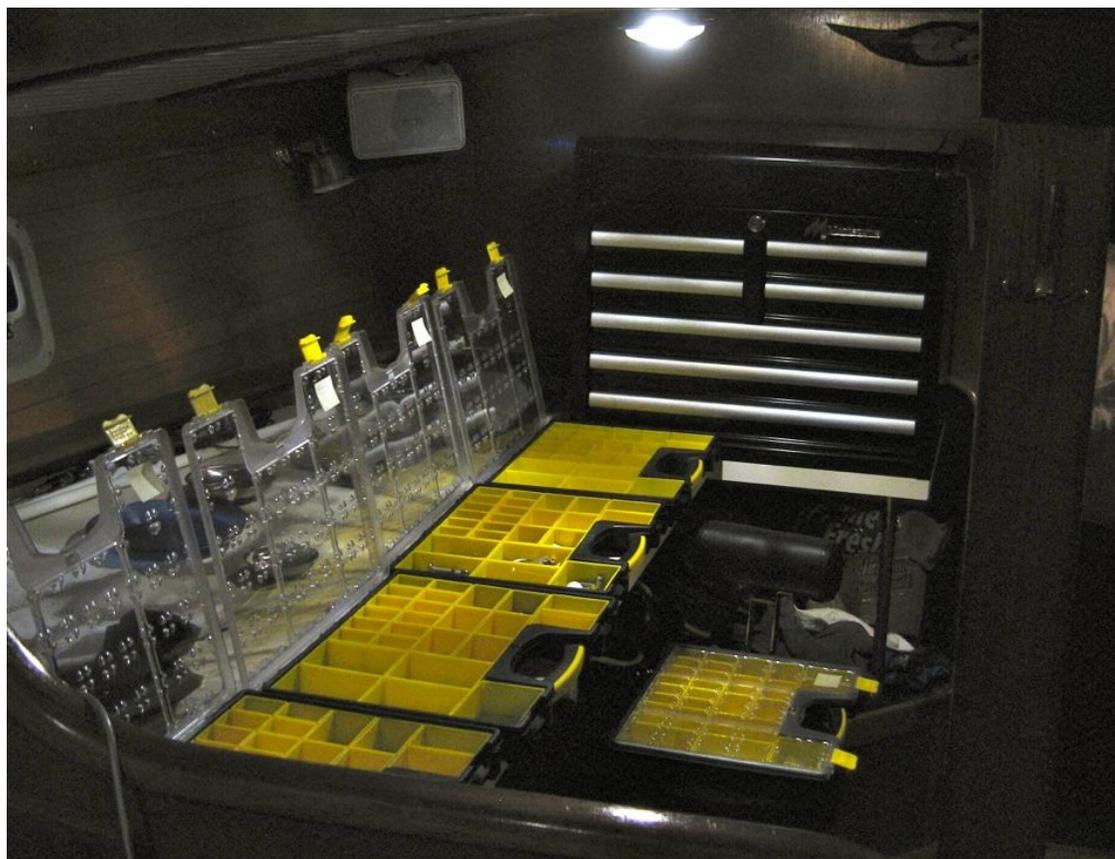
That stuff seems to work! As epoxy joints fail, I have been replacing them with a little rectangle of high-tech tape, and so far they have all stayed put. The VHB adhesive temperature range is -31° to +300° F and the foam takes care of void-filling, so hopefully this is the answer. I have gotten tired of talking about it.



Cruft Reduction

Finally, this may not be glamorous, but boy, does it feel good. All this and more has been extracted from the boat over the past few weeks... eliminating lots of mysterious cable ends labeled UNKNOWN or ABANDONED (assuming they are labeled at all). This is one of those things that I should have started doing immediately, since the noise reduction is so satisfying.

PARTING SHOTS



Parts inventory aboard has been a nuisance... drawers full of plastic bags have been so difficult to maintain that I had a work surface covered in loose clutter. For a while I was thinking of using small parts cabinets like the ones in my lab, but even with a panel holding the drawers shut they would become a giant mess in any kind of seaway.

Bags offer the most efficient packing density, but I've become fond of these boxes for ordered collections of similar items (wood screws, machine screws, crimp terminals, etc.). They are [Stanley 014725](#) (about \$16 on Amazon) and each box has 25 compartments that can be lifted out or rearranged. The hinged lid isolates them from each other pretty well (though small washers will migrate if the unit is vertical. So far, this is the most useful solution I've found for this category of on-board inventory management.

The bottom photo, of course, is Isabelle, who is fond of the space between the floppy bimini that came with the boat and the forward solar array. Eventually, the fabric will go away in favor of a rigid cockpit "roof" linking the panel and the existing dodger, which will also be upgraded with sheet stainless suitable for mounting antennas, lights, sensors, cameras, and so on.

So many projects! With the season changing and very little recent time on water (except for a day sail at the end of Tim's visit), I'm anxious to get the infrastructure jobs done before alluring conditions return. Up next: a haulout to repair a broken rudder bearing, refresh bottom paint, and add a sounder probe.

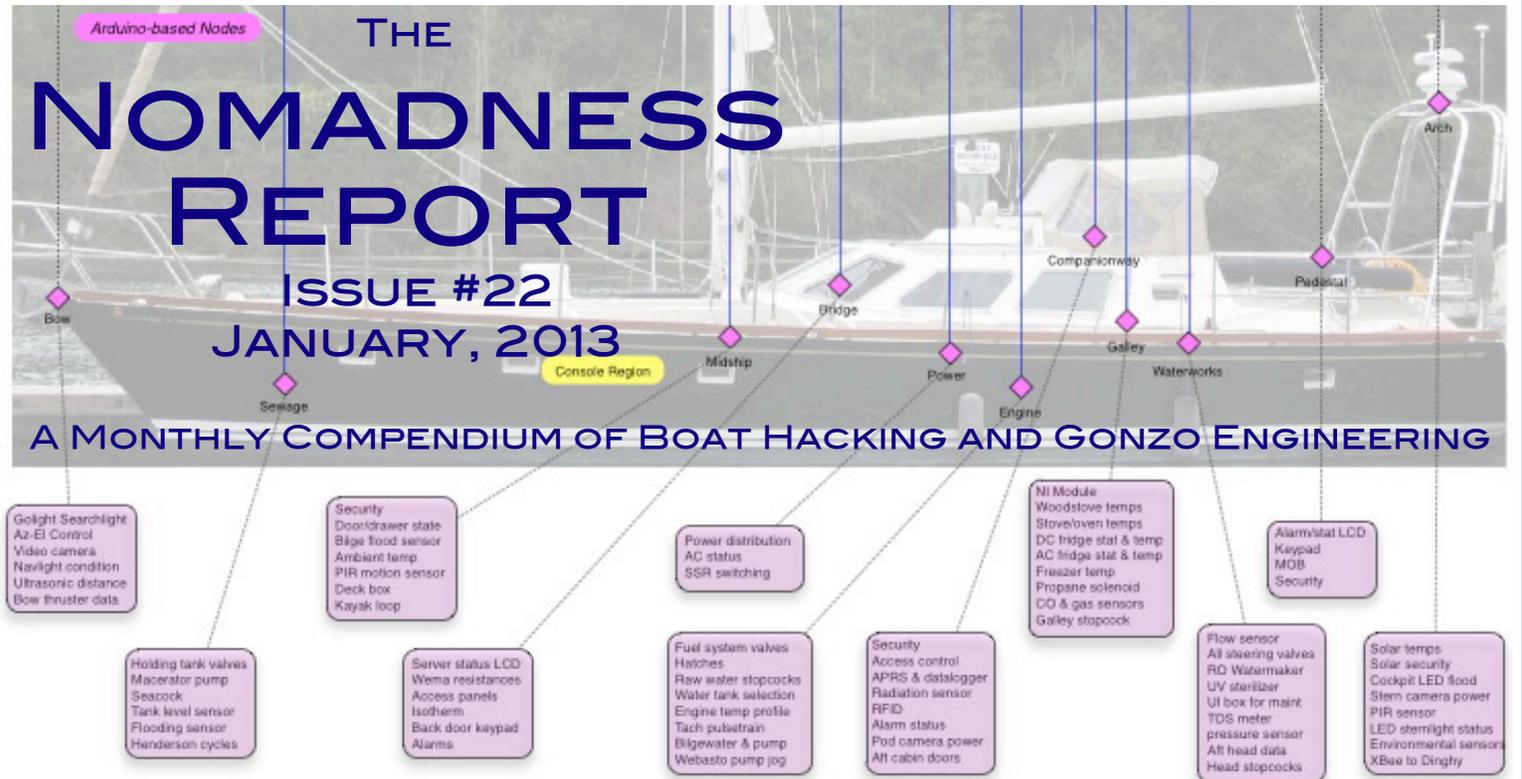
And now, on with console jobs... the teaser on page 10 is a preview of coming attractions!



THE NOMADNESS REPORT

ISSUE #22
JANUARY, 2013

A MONTHLY COMPENDIUM OF BOAT HACKING AND GONZO ENGINEERING



BREAKING GROUND ON CONSOLES

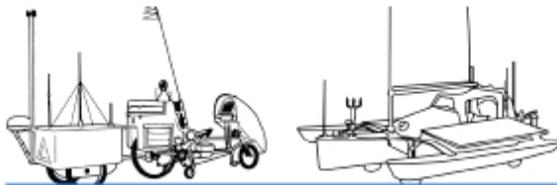
In this issue, we start with a long view appropriate to the new year... taking a page to philosophically state the intent of this gizmologically intensive *Nomadness* project. I've needed an *elevator pitch* for quite a while, and Page 3 ("The Point of All This") is the closest I've come to nailing the fundamental intent of this sprawling undertaking in a short statement... other than the obvious nautical escape/survival pod, what the heck is this all about?

From there, we zoom in to consider a collection of "use cases" for the integrated systems (including lab/studio console), then shift our focus to fabrication with a look at the first completed panel (a small cluster of nav instruments at the inside helm station). This is an easy packaging job of commercial hardware, but it sets the style for the two larger projects to follow... the power and navigation consoles.

After a quick espresso break, we look at an automated radio-check system, a few nickel-generators, and a sampling of other recent projects aboard. Having at last broken ground on panel fabrication, things are about to get very geeky around here.

Cheers from Friday Harbor!

-- Steve



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The photo above is the back of the CPU board of my first [homebrew computer](#) (1974). It seems appropriate as we at last turn our attention back to *Nomadness* geekery.

THE VIEW FROM ABOVE

One of the most common questions I hear, not surprisingly, is "what are your plans?" This question applies at every level of magnification, from a pile of Arduino nodes to the console system... from *Nomadness* herself to the Big Choices of life.

The answers have always been a moving target, as the multiple dreams that drive this are informed by technological progress, the seductive allure of blinky things, acceptance of reality, and my own evolving interests (and energy levels). When a project is so huge that it spans decades, this inevitably creates mission drift... but that is just a side effect of having many foci that shift asynchronously. But sometimes they converge, and when they do, it's a beautiful thing.

Any programmer will tell you that a key design specification is a *use case analysis*. The formal definition of this is mind-numbing, but in principle it's very simple. "What do I want to be able to do? How do I want to actually *use* this thing?" That helps establish the objectives of a design, though of course in programmer-speak there are some very formal ways to express that (I'm not going there, don't worry!).

Still, the question has come up a few times lately, and I thought I'd take time in this new year to share the process at three levels of abstraction... two now, and a third to follow in a later issue:

The first is simply the big picture: how is all this technology relevant to the creation of an agile toolset for life-support and exploration?

The second refers to the huge wrap-around control console that dominates the lab space aboard, as well as a couple of satellite regions... collectively, the stuff that will make this boat look like the set of *Star Trek*.

And the third is about these "nodes" I keep mentioning... along with the other devices that collectively bring lots of data points around the ship into a central database that has multiple clients, one of which is the user-interface that appears wherever I have a web browser.

The stunning image below goes well with this. The photographer is Wojtec ('Voytec') Wacowski, who visited in October. He scampered up to do a masthead inspection, photograph details, and carry a line through a sheave for the sky platform project... and upon return to the deck, announced with a grin: "This is instance of your Tom Sawyer fence-painting principle."

(NASA helped with the other part of the photo... and I removed a bit of a neighboring boat along with some other minor photo editing.)



THE POINT OF ALL THIS

Throughout this publication series, I've touched on some of these themes... but it's good to step back and re-state the fundamental specification. That can otherwise drift and become commingled with voyaging plans.

Full-time life aboard a vessel of this scale involves a huge learning curve and nonstop focus... with interacting systems from bow to stern that handle power, fresh water, sewage, navigation, communications, propulsion, refrigeration, life support, heating, entertainment, safety, information, and more. Historically, all these have been inscrutable clusters of non-interoperable machines, with boxes of spare parts and binders of manuals. Toss a geek like me into the mix, and there's an added layer of blinkenlights, Arduinos, servers, radios, lab equipment, audio, and even a few gratuitous gadgets to complicate things.

Obviously, this all translates into a huge mess if we're not careful... and indeed, every few months I hear from another sailor who is exasperated by the whole idea, urging me to simplify and *go now*, reminding me that everything on a boat eventually fails. And they are right: life is short, complexity is insidious, water corrodes, and salt water corrodes absolutely. But rather than take this as a warning, I see it as seductive.

Imagine for a moment that you are captain of a self-sufficient mobile pod, capable of traveling anywhere you desire. Everything is at your fingertips; not only can you drill into all your ship's subsystems via a browser (graphically integrating hundreds of sensors and derived data points), but you can explore your immediate physical environment in detail, monitor the radio spectrum from

"DC to daylight," communicate globally via multiple independent paths ranging from ham radio to satellite Internet, hunker inside while keeping watch via steerable cameras and microphones, secure your perimeter, remotely access ship systems from anywhere in the world, play the piano, produce podcasts and YouTube videos, design and fabricate new machines, and still enjoy all the benefits of a



highly evolved toolset for marine navigation with chart plotters, radar, instruments, and other tools.

Obviously, the information side of this becomes an interesting challenge. Thanks to an always-on server and a network of nodes distributed around the boat, every data point will be linked to a corresponding software object that dynamically reflects real-world changes, allowing disparate systems

to be integrated into a single environment that is accessible from any computer, tablet, or phone on board (or off). This goes far beyond replacing blinkies and gauges with pixels; once everything is integrated into an object model, it becomes possible to anticipate failures by observing aggregate behavior even if no single sensor is out of range. The database can be mined for historical analysis, and event

triggers can be as simple or complex as needed.

All that is under the hood, of course; what's more immediately sexy is the physical environment of our postulated water-borne starship. Once we accept that this is an exercise in gonzo engineering as much as physical comfort, it becomes possible to make a few changes from the traditional small voyaging craft with its saloon and dinette... why not incorporate a few additional consoles besides the basic navigation and power-management control surfaces in the pilothouse? How about adding an audio production studio, ham shack, electronics lab with hot-air rework tools, Internet alcove, computer workstation, 3D printer, and a little space for machining and other jobs?

Somewhere in these imaginings, you probably sensed the shift from essential sailing toolset to ultimate toy. The tricky part is making that leap without crushing the substrate or turning it into work; what we need here is a blend of art and engineering that retains the alluring beauty of a small sailing craft while overlaying an extravaganza of geek expressionism that ensures ongoing stimulation.

That is what this is about.

CONSOLE USE CASES

So, given that lovely high-level nautical dreamscape, let's figure out how to make it happen.

The most visible aggregation of geeky goodness is the wrap-around lab/comm/studio console, although there are two related regions that also carry high-density systems (the inside helm nav/power console, and the Zone of Hackage integrated with the Internet Alcove... it all kind of flows together but really parses into three major spaces). I recently decided that this subject needs its own web page, since it changes relatively quickly as the project develops... so here is a [current list of devices](#) grouped by region, with photos added as sections are completed (more later in this issue on the upper-helm panel fabrication, the only one that is complete at the moment).

Down in the lab, this design process is constrained by the physical limits of the space, various usability factors, and the annoying fact that most of the devices were not intended to be panel-mounted and thus require a variety of repackaging hacks. The racks are now in place... a trio of [CFR](#) series 12U frames from Middle Atlantic... and their faces have been temporarily covered with plastic "panels" to provide a brainstorming substrate. This is my CAD system... Coroplast-Aided Design.

The bottom photo shows some random moment in the evolution of the layout, which is not yet cast in stone. I cut up old file folders to represent actual-size front panels, and hang them lightly in place with bits of tape to make re-arranging easy. Audio gear is on the left, the comm center is in the middle, and the electronics lab is on the right.

Issues include overall workflow, minimizing cable-dangles in front of displays, audio system usability when the piano is in use, logical clustering by function, and minimal impact to neighboring systems when one rack frame is open for surgery. It's a generous space compared to a bicycle or *Microship*, but with all I'm trying to cram in, every cubic inch has to be used wisely.

Use Cases

I threatened a couple of pages ago to do a sort of informal use-case analysis, but have so far only offered a sort of abstract rhapsody. This would be a good time to start looking at things a little more pragmatically. To restate that question, how to I want to actually *use* this? That's the real issue that needs to drive the design process. Scoping the discussion to all matters gizmological (not just what is pictured at right), let's sketch a few scenarios in no particular order..

Audio Production

This one is kind of huge, surprisingly, especially since the original plan was to build an updated version of my old [audio crossbar](#) behind the scenes to let the server route signals among various sources and sinks. I'm still doing this, but that approach doesn't lend itself well to hands-on mixing and studio applications... so I need *both*.

I want to be able to mix multiple audio sources and route the result to the ship server, local studio Mac, SD-card recorder, stereo system, heavy-duty rack amplifier (if



I WANT TO BE ABLE TO...

this admittedly excessive item makes the console real-estate cut), or into the routing system that can pass it on to transmitters or other devices. In short, anything needs to be able to talk to anything, and the complicating factor is that some of those things require high-quality stereo audio tools and others are just low-fi monaural devices that have to work when I'm on a tight power budget.

In practice, this translates into such activities as:

- Playing the piano with local near-field monitors, along with music-workstation functionality for sequencing, layering, editing, recording and so on
- Producing a podcast or audiobook chapter using studio microphones, sound effects, and either hardware (mixer/effects) or software (DAW) editing tools... including the ability to incorporate audio from around the boat (hydrophones, comm channels, recordings...)
- Enjoying high-quality sound while using the adjacent ham radio station (including DSP filter when needed)
- Video editing
- Piping the music library and other sources into the stereo system (Fusion MS-IP700 with multiple speaker zones and a local subwoofer)
- Controlling the experimental "phaser" that is part of the ship security system (lightweight ADS)
- Routing multiple sources into the stereo FM transmitter for flotilla community use

"Playing Radio"

In addition to basic marine radio tools like the VHF at the helm and the SSB featured in Issue 21, *Nomadness* is getting a robust ham shack... including a multimode rig for voice and data on HF/VHF/UHF, dual-bander with integrated APRS TNC for location tracking and lightweight messaging, various ways to integrate radios and computers, audio processing goodies, a "DC to daylight" digital scanner, and a few other things. Some of this is essential for the ship to be well-connected, some lies in the domain of *situation awareness*, and some of it is pure radio passion that is arguably as essential as the rest.

Continuing our use-case theme, I want to be able to:

- Cruise the HF radio spectrum, rag-chewing with other hams and occasionally chasing DX (going for distance, collecting countries, etc). This not only keeps communication tools (and skills) fresh, but it's fun
- Access local ham radio repeaters
- Use UHF FM as a "back channel" remote pipe to the boat from a hand-held radio, allowing basic control and status updates via synthesized speech
- Monitor public safety, agency comms, and other traffic (digital trunking systems as well as basic simplex VHF/UHF)
- Listen to international shortwave broadcasts
- Transmit location beacons via APRS and use that toolset for flotilla tracking and basic telemetry
- Perform antenna analysis and other diagnostics



System Design

A full third of the console region is devoted to test and measurement equipment, along with a local node on the ship network and access to the on-board networks. There is a lot of R&D horsepower here (including a built-in SMD hot-air rework and soldering station)... why?

I want to be able to:

- Develop an Arduino or other node with good connectivity to the server and readily accessible tools
- Do fine-pitch soldering and PC board fabrication
- Analyze mixed-mode signals, with at least basic ability to sync to packet framing in the common protocols (CAN bus, I²C, USB)
- Have a suite of instruments that are always available and don't require unpacking and stowage... bench supply, signal generator, multimeter, oscilloscope (photo above shows Rigol products, not to correct mutual scale)
- Easily get at everything for service
- Do basic mechanical fabrication, including 3D printing

Situation Awareness

This sprawling concept really just boils down to having the tools to be cognizant of what's going on in the environment... though of course *that* word covers everything from internal ship systems to what's happening outside, on the radio, in the atmosphere, with friends, and, well, everywhere.

The "I want to be able to" list gets pretty diverse here:

- Log every possible data point related to on-board systems and store it all in a time-stamped database with front-end graphic server tools for access via browser
- Monitor the power-management system (batteries, shore, generator, solar array, and distribution... including the state of all 55 circuit breakers and the data sourced by the Outback



I WANT TO BE ABLE TO...

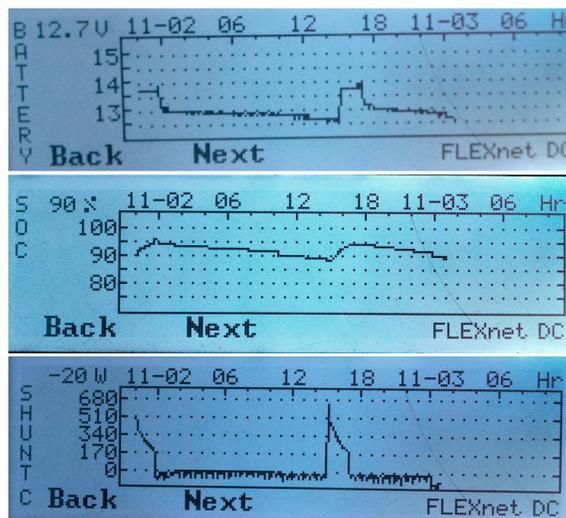
MATE3... a locally displayed sample of which is in the photo at right)

- Inhale all nav system data collected by the NMEA2000 network to bring it under the same umbrella
- Monitor every data point related to security and general watchdogging... hatches, motion sensors, cabin and enclosure temperatures, bilge water and pump cycles, access attempts, and the like
- Collect data from the plumbing nodes, notably the waterworks and sewage systems, to log cycling and usage, filter media life, tank levels, valve positions...
- Internal ship systems monitoring, including the state of all the valves controlling fuel flow, engine temperatures and other data, thermal profiling of refrigeration and heating systems, and so on
- Gather environmental and weather data from on-board sensors, GRIB files, Internet resources, NAVTEX, observation entries, and anything else available
- Share depth/location data via [ARGUS](#) as a vessel of opportunity contributing to their crowd-sourced bathymetric dataset
- Internal system model, including crosspoint network and network node activity and Internet connectivity

Network Connections

A huge part of the infrastructure here is the Internet connection along with all the stuff downstream of it; there is a whole network here in addition the the tiered star of nodes, NMEA2000 marine network, and dedicated Ethernet hub for the Outback devices. In the use-case spirit, I'll keep this oriented to the objectives, not a count of the devices or their interconnection:

- Provide multiple paths to the Internet with automatic fail-over and load sharing when feasible... at a minimum including cellular and WiFi
- Allow datacomm paths (at least for email) when no proper net connection exists (packet, SailMail/Winlink, and "sound card modes")
- Conveniently support a secure firewalled on-board network with Ethernet and WiFi (at last count about a dozen devices on the LAN including computers, webcams, wireless printers, and other gadgets)
- Make sure there is at least one "back door" into the control environment to allow power-cycling or debugging if the main server is down... probably to a somewhat smarter node that has a few extra capabilities



Development Environment

When I started the console design, I assumed it would be the location of the "zone of hackage" where most of the tinkering will take place. But most of the console stuff is fairly static once installed, and I don't want to constantly be tearing it open for surgery. The solution is the old nav station desk, which opens to expose a nice top view of a 3x2-foot box, two inches deep. This is the playground.

In the use-case domain, this is pretty simple. I want to be able to get at everything without making a mess, have good development tools nearby, decent

light, local access to all the node streams and network pipes, and be physically comfortable when in hack mode. All obvious, but deadly if overlooked.

Piloting

Finally, we must include central ship operations. This is the inside helm, the most essential console of all... and everything truly necessary to drive the boat is being brought into a single workstation independent of all the geek-intensive stuff described so far. With this, I want to:

- Control and monitor the engines, directly steer, manage the autopilot, navigate with a chart plotter, peer into the murk with the radar, talk on the marine VHF, interact with AIS, monitor instruments, and basically operate the boat without having to move to other consoles
- Augment the above with multiple live video streams delivered to nearby screens, listen to exterior sounds, and have access to a browser for the more esoteric ship system monitoring
- Observe the charge-management system, and easily reach all the circuit breakers that power everything on the boat ([current list here](#))
- Comfortably handle charts, books, and other piloting tools without having to leave the inside helm station

So that's it... in three pages, we have pretty well laid out the list of requirements from the *user perspective* without getting distracted by hardware specifics. In a future issue, I'll drill deeper and explore the object model and the way it reflects physical reality, but for now we'll take this as our set of design goals. We have some consoles to build!

Let's switch gears and look at the first packaging job in this category... the "upper helm panel."

UPPER HELM PANEL



It is nice to be able to report that the first control surface has been completed. This is located at the inside helm station, in the spot marked in bright green below on an old photo of the *Nomadness* pilothouse.

This operating position is the home of everything needed to drive the boat; in the old days, the VHF and instruments were over on the port side, difficult to see and use while at the helm. (That space on the left is now becoming the Internet Alcove and Zone of Hackage.)

The main helm console, mostly obscured by the chair back in the photo below, carries engine controls, throttle/transmission levers, a large Planar touchscreen for the nav Mac, joysticks for steering and camera control, and a few related connectors and switches. The new upper helm panel fills the space between that and the window, and hinges down for service. Given the awkward shape of the space, the VHF is mounted separately at an angle.



Referencing the photo above, the devices in this region are:

- Maretron [DSM250](#) color display for the NMEA2000 network, with a number of configurable screens for showing instrument and sensor data, nav info, fuel tank levels, and so on
- Vesper [WatchMate 850](#) AIS transponder to display other ships' locations relative to mine... and transmit mine to them.
- Two old B&G Networks [h1000 \(PDF\)](#) instrument displays, connected to masthead wind direction & speed sensors, depth sounder, and speed-thru-water paddlewheel sensor. Data is bridged to the N2K network, so these are arguably redundant, but they work well... and there are similar screens over the companionway.
- Kestrel [4000](#) weather meter for local data collection of temperature, humidity, barometric pressure, and various calculations derived from those values
- Simrad [AP24](#) Autopilot head, connected to the autopilot computer, wireless remote, and rudder-angle sensor
- MFJ [133RC](#) digital clock with WWV receiver and dual time-zone display
- Icom [IC-M504A](#) marine VHF with remote CommandMicIII at the outside helm station, GPS feed from the AIS unit, and hailer horn for external audio
- Wireless remote for [Golight Stryker](#) Az-El steerable HID spotlight on the bow, with attached video camera

There is a lot of information gathered here, but it is all pretty obvious stuff and doesn't require a lot of explanation. I want tell you instead about the fabrication process...

UPPER HELM PANEL FABRICATION



This area breaks into two sections - the hinged panel and the small section of wood framing to which objects are directly attached. The latter is trivial, and was just the usual tessellation of gadgets to make best use of available space.

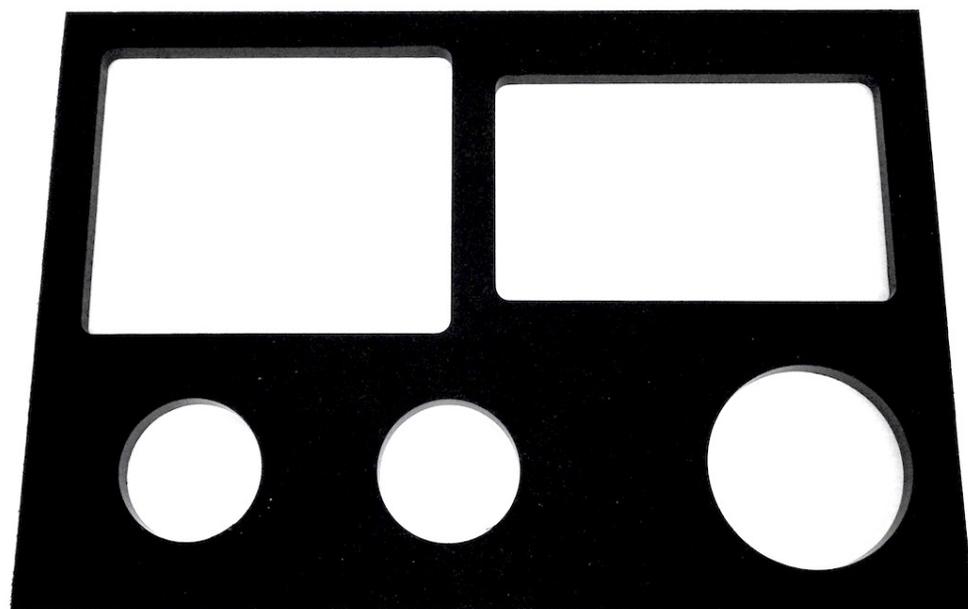
For the panel, I wanted nice looking material, easily machined, and a look that is consistent with the rest of the boat's control surfaces. Down in the lab, the rack faces will all be black anodized aluminum, but up here in the pilothouse the new panels are most easily integrated if they have the same thickness as the old ones... given existing hinges and frames. The original panels, a half-inch thick, are a very dense milky-clear plastic with white laminate, and are a real pain to modify.

After lots of research, I decided to replace them with half-inch black [King Starboard](#) material (available cut-to-size from [Tap Plastics](#)). This stuff machines like butter and even takes wood screws, and has a finely textured finish so it won't show fingerprints. The new main helm console and power panels will just drop into the same spaces as their predecessors, mounted on piano hinges, but this one is new and required a different approach.

I decided to mount it on a hinge like the others, but since making it co-planar with the lower one would require massive surgery to the boat (including the shower stall on the other side of the wall), I would place the hinge on a teak strip about 2" wide, thus spacing the panel out far enough that the backs of the instruments

and their cables would have clearance.

The project began with an 11x16" piece of Starboard, and I milled a thin lip on the bottom to hide the piano hinge edge. After much noodling and sketching, I started cutting holes, beginning with the Maretron display (photo above).



As I mentioned, the material was very easy to cut; after using a fluted mill for the two rectangular holes, I switched to a fly cutter for the round ones. This left a glassy-smooth edge (much nicer than a test with a hole saw, which left gloppy bits from melting).

The biggest hassle was hole placement. With proper template files and a CAD system, it would not have depended so much on eyeballing. That will be a recurring theme here for a while, I think; the trade-off of low-tech vs high-tech approaches to a one-off project does not necessarily favor one over the other... either way, you spend a lot of time trying to make it pretty.

(Of course, in this case, all the holes are hidden anyway. A garage-shop saber saw approach would have been fine in the long run. It's a sickness, I tellya...)

UPPER HELM PANEL FABRICATION

Once the big openings were cut, mounting the instruments was just a matter of providing each with the holes needed for its particular design... again, actual-size templates would have made this easy, but it's nothing that can't be done with ruler, calipers, and patience. The results are shown at right.

This is a good example of the problem with mixing legacy hardware with more modern tools, especially with the added annoyance of proprietary connectors. There are four different "standards" represented in that photo at right: NMEA2000, NMEA0183, Simrad's version of NMEA2000 called SimNet, and the vintage FastNet that ties B&G stuff together. There is a lot wrong with this... it is just one small part of one small boat, yet still we see the need to splice electrically equivalent devices together (Simrad vs Maretron) and install two different gateway products to interface standard (183) and proprietary (FastNet) protocols with the newer network. A hybrid package like this is high unavoidable these days without spending huge amounts of money to upgrade everything at once, and gradual evolution of the system is complicated by the need to maintain backward compatibility.

Anyway, back to the packaging! In the photos here and on the next page, you can see the panel mounted, and hinged open... the yellow B&G cables slide nicely into the thin space behind the wall, and the gray one is N2K from the Maretron with a lazy loop through an existing hole. If you peer closely, you can see the elongated pocket holes I made with the [Kreg R3 Jr](#) jig (which I highly recommend)... this magical device lets you drill precise angled holes out the edge of one board with a built-in clamping face, whereupon you use the company's special screws to fixture the pieces together without all the usual fixturing headaches. These are widely used for cabinetry and such, but what turned my head was the availability of [stainless Kreg screws](#). Right-angle attachment jobs like this that would once have been a pain are now actually rather easy, though during the learning curve I did manage to trash one hole by chasing it manually after failing to set the jig thickness correctly. I glued in one of their plugs to minimize the chance of some future skipper lying on the floor, looking up, and insulting the previous owner...

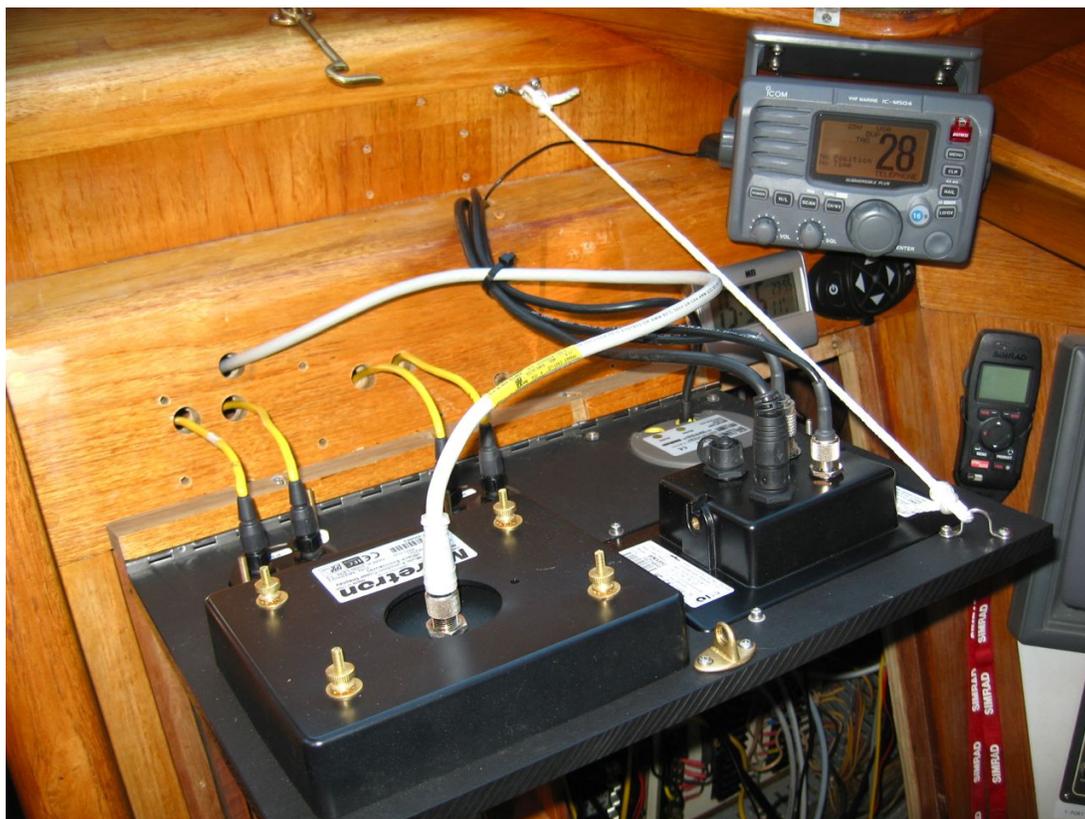


NAUTICALATTÉ

In this final photo, you can see all the pieces put together. The whole thing is really just grafted on to an existing wall, but it's clear why flush-mount would have been a nightmare. As it turned out, the VHF radio in the corner perfectly matched the offset of the new upper helm panel, so it all looks like it was supposed to be this way, at least when closed.

Serviceability is extremely easy. The hinge lets it open flat (originally it flopped all the way down, but that would have led to front panels getting dinged). It's kept under control by a couple of stainless rope guides and a piece of line tied with buntline hitches. When closed, it's held in place by a lovely brass swinging hook latch.

Next console project: the two main helm panels, navigation and power!



Nomadnespresso: 75 WH per Latté

Just across the pilothouse is an equally essential piece of equipment... a Breville [Barista Express](#) (Model BES860XL). I picked this up on a refurb deal from Amazon, and couldn't be happier... finally rid of the fiddly Hario hand grinder and Aeropress that started every day with muttering

I did worry about the AC power requirement, but metered it with a [Kill-a-Watt](#) and was relieved to see that it was acceptable at an average of 75 watt-hours per mug (including warm-up, grinding, espresso extraction, steaming, and letting it sit powered on in anticipation of the second cup). I can live with that, and still carry the other tools for times when power is a scarce resource.

The machine is well-loved by reviewers, and I researched it to death before making the investment. It's largely stainless, easy-to-use, and makes excellent espresso. (If you get this, don't get suckered into buying proprietary cleaning tablets; [these](#) are a fraction of the price for the same thing.. 100 for \$14.)

That mug, by the way, was made by my mother before I was born. Nice to have a few old family relics aboard, in daily use after decades of sitting on a shelf. If you're in the Northwest, come aboard for a nauticalatté sometime!



AUTOMATED RADIO CHECK SYSTEM

“You sound good, skipper”

In busy areas during high season, it can drive you crazy... folks calling on a busy channel to see if their marine VHF is working. It's a good thing to know, of course, but the information you derive from this method is iffy. When someone says, “you sound good, Skipper,” it doesn't have much meaning unless you also know the distance between you, the nature of both rig/antenna systems, and what the stranger means by “good.”

If you try this on Channel 16 (the calling and distress frequency where you are most likely to be heard), you're breaking the law... so in various places channels 9 and 22A have become the defaults (22A around here). But it's kind of intimidating to bother the Coast Guard for a radio check...

To address this, [Seatow](#) started setting up a string of automated stations on the East Coast in 2010, occupying the now-dormant marine radiotelephone channels (24, 26, 27, and 28). These [Maritel rigs](#) consist of a Motorola Radius marine VHF and the [ADS-SR1 simplex](#)

[repeater](#) from Argent Data Systems, along with a high-gain [TG-5 antenna](#) from GAM Electronics. Whenever the station hears a transmission, it temporarily records it... then pauses a couple of seconds and transmits a voice announcement along with a replay of the captured audio, followed by a safety-related announcement.

The beauty of this is that you can hear your own signal and you know where the station is located. This provides much more useful information about how well your rig is working, and you don't have to bother anybody to get it!

A month or so ago, after installing the [Icom M504](#) in *Nomadness*, I was sitting at the dock wondering if it worked. Like most folks, I hate bugging the Coast Guard for radio checks, and a quick exchange with the Port of Friday Harbor only told me that my signal was making it a few hundred yards. I did a web search to confirm that it was still OK to use channel 22A for a test, and stumbled across the [Seatow](#) link above... but was immediately frustrated to discover that there



were no stations in the Pacific Northwest! I sent them a note and we started talking... and I am delighted to report that I now host an automated radio check machine at my lab on VHF channel 28, along with the net-connected AIS receiver I described in earlier issues (you can see both antennas in the photo at upper left).

The shelf of hardware below that is bolted to the wall of the lab, and includes the Apple Time Capsule, SR-162 AIS receiver connected to the J-pole antenna, power supply (I'm lazy), Linux box for AIS forwarding, and the radio check system stack connected to the tall collinear antenna.

I've been quite delighted with the range of this, and have been trying to get local mariners to test it and report their results. I took a handheld VHF on the ferry to Anacortes last week and was surprised by how well it worked (much better late at night, interestingly), and have been logging all signal reports on [a Google map](#).

If you are in the Pacific Northwest, please give this a try... just call for a radio check on channel 28 and let me know what happened (and feel free to use it all you want while sailing about, of course!). Let's get some more data points on that map...

NEW NICKEL GENERATORS

TecNec Dealership

When I went on a quest for a vendor of the Middle Atlantic rack hardware for the on-board lab, I found a company in New York that backed up their retail division with a rather huge wholesale operation... and as discussion progressed, we found ourselves discussing the idea of setting up a dealership in the San Juan Islands. I'm still not really sure where this will go, given my scarce available clock cycles during this huge project, but Nomadic Research Labs is now a TecNec dealer. Need any pro-audio, broadcasting, security, video, or other related gear?

From what I've been able to tell so far, this is most likely to be interesting to folks who want to put together an order of multiple goodies... my discount varies quite a bit from one product line to the next, and in the consumer domain it's hard to beat eBay and Amazon for a single item, especially with shipping overhead. But if you have a studio wish-list, I'd love to take a crack at it. This is still very new and I'm feeling my way, but I may be able to save you some money. I put a [full vendor list](#) and a little more information on my website... holler if anything catches your eye!

Hard Core Dock Cleats

My moorage in Friday Harbor was built by [Northwest Docks](#), and is a gorgeous thing. The company produces its own industrial-strength cleats (in 316 stainless and aluminum), stronger than the normal chandlery stuff that's out there, more generous with spacing, and much smoother than the cast models that will chafe lines over time.

The company owner (Jim Guy) is a friend of mine, and somewhere along the way I asked if he's selling the cleats to individuals. One thing led to another, and now I'm his dealer for these things.

I have an [online store page](#) with pricing, and can give you more tech specs if needed. Nomadness is attached to 12-inch stainless cleats, and I don't worry about them when the wind blows. Recommended.



Nomadness Surplus

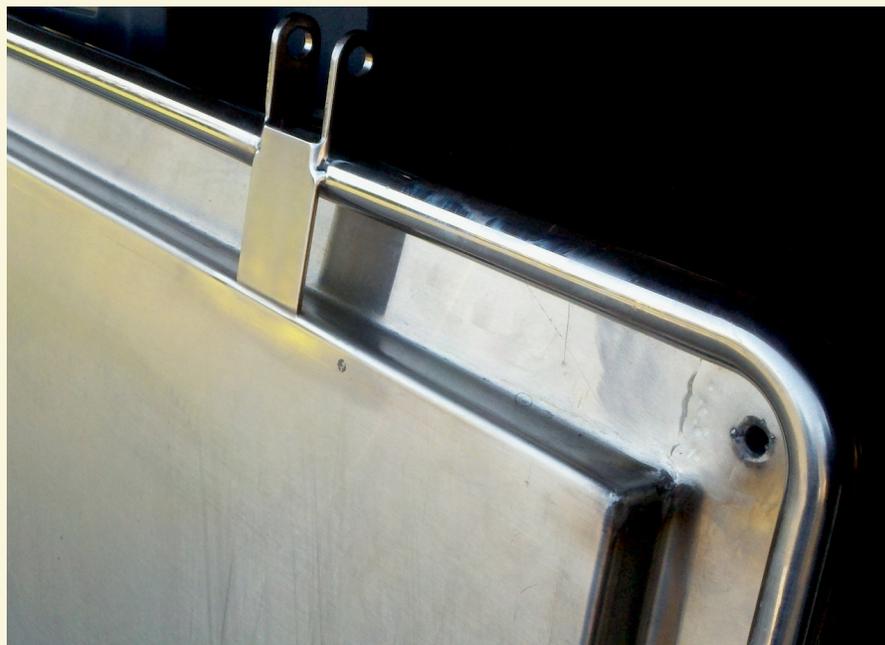
Finally, all these projects over the years, coupled with chronic GAS (Gear Acquisition Syndrome) and a difficulty letting go of things, has led to an absurd mountain of tonnage that feels like a million tiny anchors. I occasionally go on eBay marathons, and need to again... but I've also set up a corner of the online store for [NRL surplus](#). Since this is just a Wordpress site, it's easy for me to add things... and a few have already found new homes.

This includes some boat goodies, geeky things, music hardware, and whatever else catches my eye. The latest addition is a complete piano studio based on a Roland RD-700SX, Mackie mixers, four KRK monitors, custom desk, and more.

SHIP UPDATES VARIOUS

Scratching Mast

Isabelle got tired of being yelled at for using the back of my pilothouse chair as a scratching post, so she had me purchase [100 feet of 3/8" sisal rope](#) and wrap it around the mast partner. I only bother to mention this because my first attempt was with a roll of rope from the local hardware store (same stuff you find in the big-box stores), and it smelled like diesel. Seriously... it reeked. They were kind enough to take it back, and I did some research... this is the stuff, with no smell at all.



Aft Solar Substrate

You may remember the gorgeous work done by Derek Peterson over the summer, fabricating the forward solar substrate that was then integrated into a working 180-watt array when Tim Nolan was here for a "geek's vacation." That has since been wired into the system via the Outback [FLEXmax 60](#) solar charge controller, and is working well (while providing more antenna-mounting space).

The other 240 watts is next, and will hinge off the radar arch and be supported by the dinghy davits. The stainless substrate is now done, and is a thing of beauty... you're looking at the top side, with its surrounding moat for water catchment and one of the two drain ports. This is going to be a physically difficult installation job, so it will probably gather dust until I have some help, but it is wonderful to have the hardest part done. The cabling and circuit breaker are all in place, awaiting another surge of free electrons to keep the espresso machine going.

Aero Headset

This is just a quick update, as it's part of a much larger system that will justify a detailed article, but I've been working on audio routing. In addition to the obvious (stereo system with mixer and local speakers for radios), there will be a crosspoint network for behind-the-scenes switching as well as a few alternative I/O devices. One is an Icom front-panel speaker in the console with DSP filter for noise reduction, and another is this aeronautical headset with boom mic.

This is a Flightcom *Denali* that I picked up locally for a song, and I'll add the pair of jacks to the console's audio region along with a switch to manually select the audio channels. A boat can be a high-noise environment (engine, nasty weather), and it can sometimes be hard to understand radio traffic.

Of course, I'll also have about a kilowatt of audio amplifier, but that's a lot of big iron to fire up. This should be a good alternative when things are nasty or crew is sleeping.



STATE OF THE PROJECT - 2013

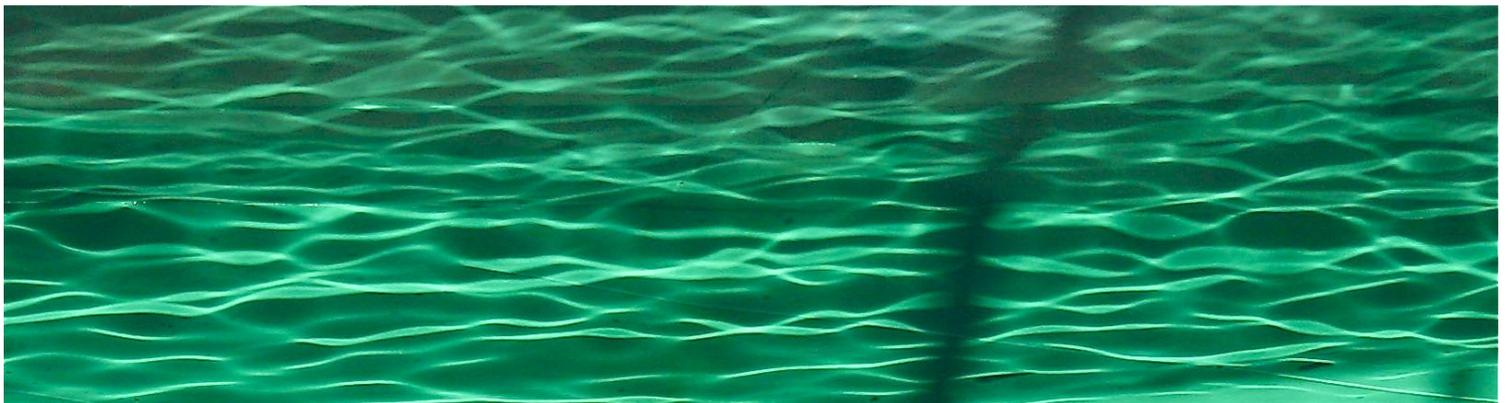
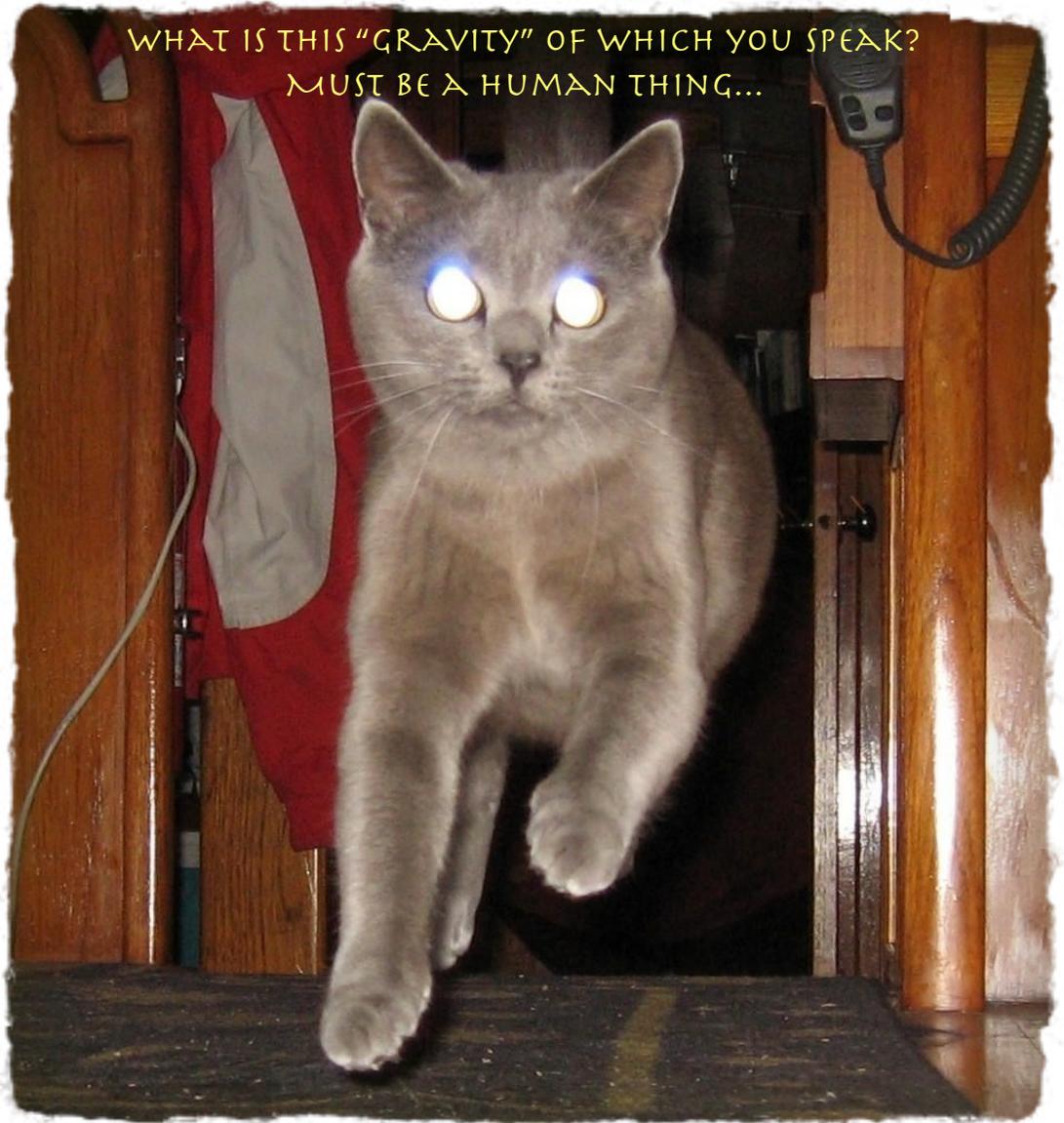
This issue was a long time a-comin', and for that I can blame the confluence of overload, seasonal affective disorder, and a couple of health-related issues (back pain and sleep) that steadily drain energy.

Fortunately, there has been progress... some tangible, some in the planning domain. The parts for the next two console projects (power and nav) are all on the bench, various jobs are getting ticked off the [list](#), and I'm homing in on some of the big decisions in the lab region (type of seat, keyboard choice, panel layout, and more). It has felt slow lately, with cold slogs up the hill to the lab and a high talk:do ratio, but things are moving forward.

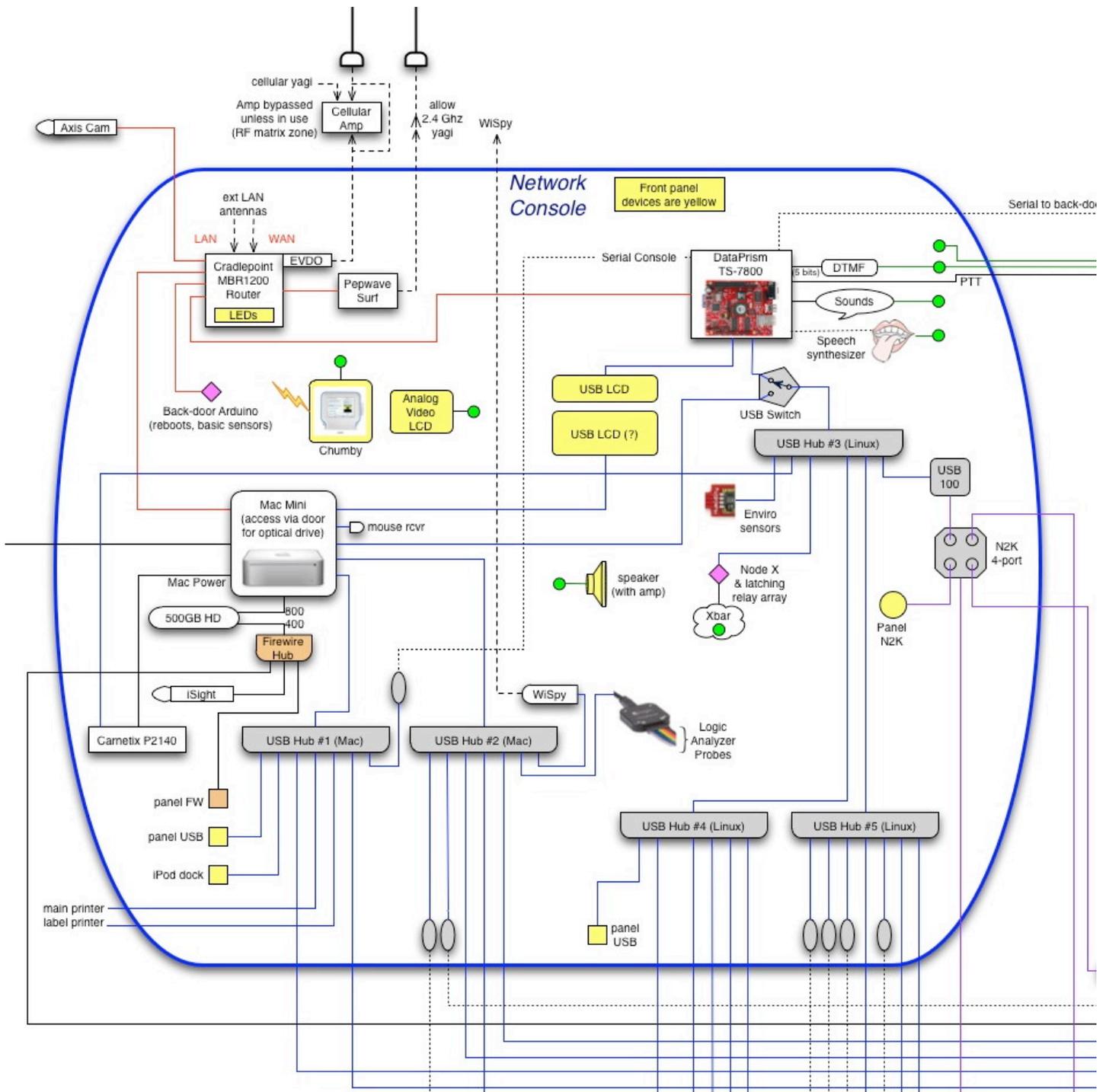
I'm keeping the voyage plan for 2013 realistic... starting with a haulout in Anacortes to take care of inspections, bottom paint, and sounder installation... then continuing through the season with a succession of relatively local jaunts to shake out new systems and enjoy the spectacular cruising destination that is our new home port.

The key thing is to follow my old rule: keep moving in the same direction for a long time. Steady progress is what leads to wondrous things... avoiding the constant temptation to re-think, re-design, and re-direct the project to new and seductive ends. Here there be dragons.

WHAT IS THIS "GRAVITY" OF WHICH YOU SPEAK?
MUST BE A HUMAN THING...



The Nomadness Report was published from April 2011 until January 2013, with 22 issues totaling 195 pages. This book is a compilation of the full collection, with some added annotations and resources. To read about projects done after this period, please reference the [Nomadness Blog](#).



Links and contact info:

- Nomadic Research Labs: microship.com
- Research vessel and blog: nomadness.com
- Contact Steve Roberts: wordy@microship.com