E-Craft

Cutting-edge vessel design constructed in Ketchikan, Alaska.

The vessel's center deck is raised and lowered by a hydraulic system with four guide posts and eight hydraulic rams. In the down position, the center deck's flotation raises the side hulls and lowers the draft from 12' to 4'6".

Alaska Ship & Drydock

In its deep-draft, SWATH mode, the *Susitna* can cruise at 17 knots in open water or at 5 knots in two feet of ice.

By Bruce Buls, Technical Editor

The concept of a variable-draft landing craft for the military has been floating around for years. How the concept evolved into an arctic ferry as well as an expeditionary warfare demonstrator is the story of the *Susitna*, a new SWATH icebreaker that can drive on and off unimproved beaches.

The *Susitna* is the brainchild of many people, but the most important are now retired Navy officers. Lew Madden is a former Navy captain who worked as a project manager for **Lockheed Martin** in the 1990s after his time in the service. It was at Lockheed that Madden helped formulate and develop a concept known as the Vari-Craft, a high-speed landing craft with variable draft. In its early stages, the Vari-Craft was a propeller-driven SWATH with four thruster pods. It also included a center section that could be raised and lowered for operating in different modes.

The other key Navy player was Adm. Jay M. Cohen, former chief of the Office of Naval Research. During his time at ONR, Cohen championed the development of several innovative vessels, including both the X-Craft and the E-Craft, the Navy designation for the *Susitna* design.

"The 'E' is for expeditionary," said Cohen. "It's because we wanted to send a message about why the Navy and Marine Corps are involved."

The Navy and Marines are involved because they are looking for a better way to get troops and equipment to and from undeveloped beaches anywhere in the world. Cohen also describes the concept as a "connector."

"Lockheed Martin had this idea to build a connector that would have three operating modes," said Cohen. "Alongside the replenishment ship at sea, 50 to 100 miles off the beach, it would be in the SWATH mode, would be very stable, and we could transfer large things like tanks and trucks and fill-in-the-blank from the support ship to this connector.

"Once that transfer is done," Cohen continued, "this SWATH catamaran would pull away from the ship, deballast its tanks, and now its hull form would be such that it's operating as a high-speed catamaran. It would run to the beach, and when it got to the surf zone, it would stop and drive down the center barge and everything on it. As it hits the water, Archimedes' principal, you develop buoyancy and it starts lifting the two deep hulls until the mean draft of the ship at that point is about four feet. You then drive the ship's nose, its stem, on the beach, the bow door opens and the M1 tank rolls off, the supplies roll off, and they engage the enemy."

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Cohen said the military sees the variable-draft connector/landing craft being built from aluminum to keep weight down and speed up. It also envisions it being about twice the size of the 195'×60' *Susitna*.

But this is a proof-of-concept vessel, so size and materials aren't as important as the engineering for the Navy.

For the *Susitna*, however, materials and construction are just as important.

Unlike most ONR demonstrators, the *Susitna* will not be owned and operated by the Navy. Instead, Alaska's Matanuska-Susitna (Mat-Su) Borough, which is north of Anchorage and across Knik Arm at the north end of Cook Inlet, will own and operate the vessel as a ferry. Without ferry service on the two-mile passage, the only way to get between Anchorage and Port Mackenzie and other Mat-Su communities is to drive about 75 miles.

Mat-Su officials see the ferry as important to economic development because it needs a better transportation link to the urbanized Anchorage area to grow.

Plans for a bridge to cross Knik Arm have been in the works since 2003, but funding and permitting are not yet in place. A railroad spur is also in the planning stages.

While still with Lockheed Martin, Madden met some Mat-Su officials at a high school reunion in the Anchorage area and told them about the Vari-Craft. He said the concept appealed to them because the boat could land at both established docks and remote beaches on Knik Arm and Cook Inlet. And properly built, the boat could break ice during the winter months.

The Mat-Su Borough got involved in 2002 and has since invested about $5.5 million in feasibility studies and design work. Now retired from Lockheed Martin, Madden has been working as Mat-Su's rep at the shipyard, **Alaska Ship & Drydock** in Ketchikan.

KETCHIKAN SHIPYARD

That one of the most complex surface vessels ever built ended up

being constructed at a small shipyard in Southeast Alaska is a testimony to Cohen's astuteness and Mat-Su's desire to have the boat built in Alaska. Not only is the yard remote, but it had only built one new vessel (a double-ended ferry for the Ketchikan airport).

When Cohen was looking for a yard to build the E-Craft, he was also completing another newbuild project, the X-Craft, at **Nichols Brothers Boat Builders** in the Seattle area.

"When cost is a driver," said Cohen, "to me as a customer, you want the yard that can do it but has the absolute minimum overhead and the strongest motivation to accomplish the task on cost, on quality and on schedule. Yes, there was risk, just like there was risk doing the X-Craft at Nichols Brothers, which is a very small yard that had never done a military vessel.

"And because Nichols had proven their worth to me when building the X-Craft and controlling costs and the high quality of that vessel," continued Cohen, "I was confident that Randy Johnson [president of ASD] and his commitment — and what I saw in the shipyard — that they would do the job and do it well. And in the end, this was about an Alaskan ferry. Who better to be held accountable for the success or failure of that than an Alaskan and an Alaskan shipyard? Those were significant factors."

Cohen added that going with a small shipyard would also save time and money. "To design-build that vessel at any tier-one shipyard would have cost two to three times as much and would not have been done in the same period of time," he said. "It would have been a round-off error on their bottom line.

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In the down position, the center deck is lowered 21' and allows the vessel to be beached.

And their focus would have been on their mainstream product line. That wasn't the case for Alaska Ship and Drydock. They were going to rise or fall on the success, quality and performance of the E-Craft. And as a custodian of the taxpayer's money, that was a big driver for me."

KEY PLAYERS

Another key player recruited by Cohen was Guido Perla, the head of the Seattle-based naval architecture/marine engineering company, **Guido Perla & Associates**, which did the detailed design for the

The center deck, which can carry 35 long tons, in the raised position.

Susitna. After getting recommendations from Matt Nichols, Randy Johnson and others, Cohen contacted Perla and met with him in Seattle.

"Initially Guido thought I was crazy and wasn't sure he wanted to participate in this complex project," said Cohen. "But I told him about the high regard that everyone held him in, and I basically challenged Guido to come on the team and make it a success. He couldn't refuse a challenge and the rest is history."

"Yes, it was a challenge because this had never been done before," said Perla. "It was a challenge to keep the vessel within the estimated weight that it could have. You have regulations for a passenger vessel, you have classification requirements, and you have strain requirements for the structure for ice-breaking. You have to understand that this is the first-ever twin-hull SWATH that is an icebreaker. Nobody has done that before. =That was a very pioneering thing. We had to really stretch everything because there was no record.

"We had to work very closely with the American Bureau of Shipping because they didn't have anything applicable for a vessel like this," Perla continued. "And any other classification didn't have anything applicable. We had to do model tests to develop our own pressures and values to use for the design. And that was very challenging. And so was developing the shape of the hulls to be able to break ice."

Because the E-Craft was going to be a commercial ferry, it had to meet firefighting, lifesaving, and damage-control requirements of not only ABS, but also the Coast Guard.

WEIGHT CONTROL

The original concept envisioned a variable-draft vessel that operates in three modes: SWATH, high-speed catamaran and shallow-draft landing craft. In the end, the *Susitna* will only operate in two: SWATH and shallow-draft. The problem is weight. In order to make the hull strong enough to plow through up to two feet of ice at five knots, there needed to be a lot of steel. And as more steel was added and the weight grew, bigger engines were needed — and more support structure — and the

weight grew even more. What had been conceived as a 600-ton vessel grew to almost a 1,000-ton vessel.

Even so, the engineers and builders did everything they could to shave off weight. For example, carbon-fiber shafting was used instead of steel. The transom plate was carefully machined down from two inches to one inch in places, a move that saved 1,300 lbs.

"Weight control was the internal mantra throughout the design and construction," said Mike Shrider, one of the marine engineers who worked on the project.

Although the *Susitna* is generally described as a twin hull — it is, after all, a SWATH (small waterplane area twin hull) — there are actually three hulls if you count the aluminum section in the middle.

When operating in deep-draft mode, the middle section, which is made from aluminum and was built by **Latitude Marine** in La Conner, Wash., sits high above the water, flush with the passenger compartments on both sides of the vessel. At this point, it's essentially a deck suspended between the two hulls.

But when a pair of 50-hp electric motors (one per side) energizes the hydraulic system, the center deck section can be lowered 21'. As the deck is pushed into the water, it becomes a hull with significant flotation. At the bottom of its travel, the twin hulls on each side have been pushed up from a draft of about 12' to only 4'6".

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The 'ice knives' above the waterjets will help protect the four jets from ice in Alaska's Cook Inlet.

At this draft, the four **Wärtsilä** axial-flow waterjets are completely out of the water. Propulsion is then provided by a pair of 360° thrusters from **North American Marine Jet** that are mounted on each side, amidships.

"We needed the mid-hull thrusters to maintain the yaw and attitude as you go into the beach," said Cohen, "otherwise you'd be beached sideways. And you also need that for the ferry operating against some very strong currents between Anchorage and the Mat-Su Borough.

"For almost all ships that are de-

signed to ground, like a landing ship tank and others, once you're on the wet sand, it forms a suction and you have a very difficult time breaking away from the beach. That's why we designed these mid-hull thrusters, which are flush with the keel to be able to turn and bring in water from the side and flush it along the keel going forward to erode the sand with bubbly water so we could back off the beach. That's really an exquisite application of thrusters. And no one else does that."

Powering both the waterjets and the thrusters are four **MTU** diesels, each rated at 2,735 hp. Each engine has its own, very cramped engine room down in the hulls. Using all available power, top speed for the *Susitna* is 20 knots in open seas. Normal service speed will be 17 knots.

Up to 20 vehicles or 35 LT of cargo can be carried (and lifted) by the center deck section, and up to 114 passengers can be accommodated.

SUSITNA SPECIFICATIONS

Builder: Alaska Ship & Drydock
Designer: Lockheed Martin/Guido Perla & Associates
Owner: Matanuska-Susitna Borough
Mission: Vehicle/passenger ferry, military demonstrator
Length: 195'5" **Beam:** 60'
Draft: 12' (deep-draft mode); 4'6" (shallow-draft mode)
Hull Material: Steel
Vehicle Deck/Pilothouse/Passenger Compartment Material: Aluminum
Main Propulsion: (4) MTU 12V4000 M90, 2,735 hp at 2,100 rpm
Marine Gear: ZF, 3.48:1 (thrusters); Nico, 2.644:1 (waterjets)
Waterjet: (4) Wärtsilä WLD 810
Thruster: (2) TRAKTOR JET 1016HT 360 Thruster Jet
Ship's Service Power: (2) MTU S60/ Marathon Electric Magnamax, 300 kw
Speed (knots): 20 max.; 17 cruise
Deck Capacity: 20 standard vehicles or one M1A1 tank
Cargo Capacity: 45 LT
Electronics: 40S EPIRB; 45SX EPIRB; (2) SART; (2) VHF radio; MF radio; GP150 GPS; Manta digital radar system; ECDIS; X-band radar; S-band radar; Night Vision system
Passengers: 114
Certification: ABS +A1, (E), HSC, Ro-Ro Passenger Craft, Alaska Cook Inlet, AMS, Ice Class A0; SOLAS; MARPOL; COLREGS
Delivery Date: Nov. 5, 2010

FERRY SERVICE

The *Susitna* will not enter service as a ferry until some time next year. The Mat-Su Borough and the city of Anchorage are still trying to figure out just where and how the vessel landings will be accomplished on both sides. Several different scenarios are under discussion. Lew Madden has even contacted the Hawaii Department of Transportation to see if the landing barges they built for Hawaii Superferry might be adapted for use with the *Susitna*.

How much the landing-craft mode will be used other than for testing

remains to be seen, but generally cars, trucks and other cargo will be loaded and unloaded in the deep-draft mode.

The Navy has had over 1,000 sensors installed throughout the boat to gather data for its ongoing design and engineering analysis. The boat will also be used during exercises with Stryker vehicles based near Anchorage to test the landing-craft aspects of the design.

Beyond its use as a ferry and as a proof-of-concept for the Navy and Marines, the *Susitna* is seen as a potential support vessel for a variety of applications. Because it was designed and purpose-built for some of Alaska's harshest operating environments, it could provide marine transportation between small, remote villages. It could also be used for oil-spill response or oil-and-gas exploration, and as an emergency response vessel for Anchorage's airport.

For Randy Johnson and his team at Alaska Ship & Drydock, the sleepless nights associated with a very complex design-build project are about over. The yard has proven that it is capable of meeting extremely demanding specifications and has developed several innovative processes and techniques along the way. They built 36-foot/30-ton modules to within 1/16" tolerances. They reduced the number of hours for panel construction from 40 to four. In Madden's words, "They just slammed it. Nobody could believe that they could do this."

"We knew there were risks, and ONR knew there were risks, but that's what science and technology is all about," said Johnson, ASD's president. "Probably what kept us awake at night the most was developing a build strategy that would be efficient but also provide for the tight tolerances that we knew would be required due to the unique hull form and lift system.

"Being able to secure a contract like this and then perform for our employees and community, there's just tremendous pride that's developed as a result of that. There's nothing like being able to have our folks say, 'Hey, I helped build that ship.' " WB