FIFTY YEARS AGO this month the greatest naval armada the world has ever seen gathered at a rendezvous point in the English Channel. In the early morning hours of June 6, 1944, some 18,000 airborne troops parachuted into Normandy. Four thousand landing craft started their long runs to the beaches as aerial and naval bombardment shook the German-held coastal strongpoints. The complex operation code-named Overlord began to unfold, signaling a long-awaited turning point for World War II in Europe.

But why did the Allies choose June 6th? Almost any invasion date in May or June would have left the entire summer for the planned drive across France toward the German homeland, before bad weather in fall or winter could set in to slow the advance. The specific date, major participants later stated, was set for astronomical reasons.

General Dwight D. Eisenhower, supreme commander of the invasion forces, decided that preparations were not complete in May and that the next suitable period for the attack was June 5th, 6th, or 7th. In his mind each of these three days offered the right combination of lunar phase, tide, and time of sunrise. The selection of the actual day depended upon weather forecasts.

Admiral Chester W. Nimitz, in his account of the U. S. Navy during World War II, further explained how the plan-
ners had sought the most favorable combination of natural conditions. A moonlit night preceding D-day would help the airborne divisions reach their assigned objectives before sunrise, but the all-important factor was the tide. To meet varying tidal conditions at the five assault beaches, H-hour — the designated moment when the first waves of landing craft would grind ashore — ranged from 6:30 to 7:55 a.m. British Double Summer Time.

In his memoirs Prime Minister Winston Churchill also stressed the astronomical factors. To approach the French coast by moonlight would help both the assault ships and the airborne troops. In addition, a short period of daylight before H-hour would assist in the orderly deployment of landing craft and make the covering coastal bombardment more accurate. “Then there were the tides,” Churchill wrote, adding:

Only on three days in each lunar month were all the desired conditions fulfilled... If the weather were not propitious on any of those three days, the whole operation would have to be postponed at least a fortnight — indeed, a whole month if we waited for the moon.

BRIGHT MOONLIGHT

For the night of June 5–6 when the actual assault began, our computer calculations show that the Moon was 99 percent illuminated. It reached full phase at 19th UT on June 6th. But a bright Moon in June always runs fairly low in the sky when viewed from the Northern Hemisphere. It has a large southern declination because it lies nearly opposite the midsummer Sun.

Indeed, at its highest point in the early hours of D-day, when the bright Moon transitied the meridian at 1:22 a.m., it stood only 23° above the southern horizon. Nevertheless, the slanting moonlight illuminated the ground sufficiently as troops of the 82nd and 101st Airborne began dropping from the sky between 1:15 and 1:30 a.m., following pathfinders who had jumped about an hour earlier.

The dawn hours of June 6th also provided the light desired for preparatory bombardment, as the table on the facing page shows.

THE ROLE OF TIDES

General Omar Bradley, commander of the American ground forces, considered tide conditions even more important than moonlight and the time of sunrise:

On the question of tides the army had to be insistent, for there we could not give in. Twice each day the Normandy beach was flooded by a mountainous Channel tide that rose approximately 19 feet from low to high.

Indeed, the entire Overlord operation depended on the demolition teams, who would clear the way for the vast invasion forces on the landing craft that had filled the English Channel. Since the configuration of the Sun and Moon determines the tides, the clearance of beach obstacles was probably the component of Overlord most affected by the astronomical factors.

On the Normandy beaches, the invasion forces were confronted by four types of mined obstacles (see the drawing below). According to demolition-team member Lieutenant Carl Hagensen, the most difficult type to overcome was the “Belgian gate,” a vertical 10- by-10-foot steel lattice propped up by angle iron and weighing about three tons.

The method Hagensen devised to deal with the Belgian gates involved filling elongated canvas bags with the newly developed plastic explosive called C-2. Sixteen of these packs, tied at vital spots and exploded simultaneously using “primacord,” were required to topple each gate.

Beyond the beach obstacles, there were a few yards of dry sand above the high-water mark, a bank of “shingle” (large, round, water-worn rocks), and a sea wall topped by concertina wire. Above the beach, a level grassy area exposed...
tended to steep bluffs where the German defenders had built their strongpoints. Despite such obstacles, the initial assault troops were supposed to land at 6:30 a.m. and proceed to the sea wall and the bluffs. The demolition crews would follow within two or three minutes.

Chief Bill Freeman directed the efficient work of a combined team of Army engineers and naval demolition men near the west end of Omaha Beach. As his landing craft grounded and its ramp dropped, the chief noted that his watch read 6:33. Men loaded with 40-pound packs and combat gear splashed forward through waist-deep water as sniper fire increased.

While the engineers worked on the first line of Belgian gates, Freeman and his Navy crew advanced to the ramps and stakes beyond them. Francis D. Fane described the pandemonium:

"Gunner's Mate Bob Bass raced from obstacle to obstacle unreeving the heavy drum of primacord, tying the main fuse to each of those on the obstacles. ... He looked to Freeman for the signal to fire. But the chief couldn't give the word. A new obstacle, a living one, had just blocked the area. ... An infantry-filled landing craft, delayed and drifted off course, arrived ten minutes late. Instead of being already on the beach driving off snipers, the infantrymen wading from their assault craft dropped flat among the explosive-laden obstacles, pinned down by the terrific fire. Grimly Chief Freeman and the Army lieutenant drove them away. ... The signal was given at last — twenty minutes after the team had landed — and Bass pulled the fuse. The purple warning signal smoked skyward. "Hit the deck!" Freeman yelled.

A heavy roar drowned out the battle's din for the prone men. The whole gap area spouted water, smoke, wood, sand, and steel high into the air. ... The gap was blown clean...

So ran the report of a successful gap clearance. Not many teams were so lucky. Of the sixteen channels to be blown, only five were cleared along the entire front of Omaha Beach that morning. (The Naked Warriors, 1956)

In fact, most of the other crews suffered delays from currents, faulty navigation, mechanical problems, and the intense gunfire. After 7:00 a.m. the tide was rising so quickly that the delayed crews had to abandon their attempts at blowing up the obstacles. They were forced to wade ashore to wait for the afternoon low water.

The novelist Ernest Hemingway, acting as a war correspondent, encountered some of the beach obstacles that remained. He remembered the promise: "The Army is going to clear the obstacles and the mines out in the first thirty minutes," Captain Leahy had told him. "They're going to cut lanes in through them for the landing craft."

But as Hemingway's boat approached Omaha Beach:

"It was difficult to make our way through the stakes that had been sunk as obstructions, because there were contact mines fastened to them, that looked like large double pie plates fastened face to face. They looked as though they had been spiked to the pilings and then assembled. They were the ugly, neutral gray-yellow color that almost everything is in war. ... The ones that we could see we fended off by hand. ..."

The famous thirty-minute clearing of the
channels was still a myth, and now, with the high tide, it was a tough trip in with the stakes submerged. ("Voyage to Victory" in Collier's magazine for July 22, 1944)

TIDE CALCULATIONS

To calculate the Normandy tides, we used the same computer program based on harmonic analysis that was described previously in this department (S&T: November 1987, page 526). Port-en-Bessin, a small fishing village just east of Omaha Beach, is a subordinate tide station to Le Havre 60 kilometers to the east-northeast. We located a list of harmonic constants for Le Havre that was compiled in 1930 by the International Hydrographic Bureau. Using tables of tidal differences, we then derived harmonic constants for Port-en-Bessin.

We calculate that the morning tide range on D-day was about 18 feet. Perhaps the most curious feature of the tide curve is its asymmetry, showing a very rapid rise from low water to high water in about 5 hours. In the 30 minutes following H-hour (6:30 a.m.) the water level rose 2.4 feet as the demolition teams struggled to place their explosives.

By 7 a.m. the water was rising at the remarkable rate of 1 foot every 10 minutes, and it accelerated even further thereafter. Even a small delay had serious consequences. Our calculations help explain why the demolition crews were able to clear only five of the planned 16 gaps in the obstacles on Omaha Beach before the advancing tide forced them to wade ashore.

Recently Bradley Schaefer pointed out the importance of moonlight in setting the date of many World War II events (S&T: April 1994, page 86). In the case of the Normandy invasion we find that astronomical factors were a mixed blessing, for the full Moon's grav-

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The five invasion beaches in Normandy were code-named Utah and Omaha in the American sector, and Gold, Juno, and Sword in the British sector. The authors computed tides for the village of Port-en-Bessin, near the east end of Omaha Beach.
Admiral Chester W. Nimitz:

"The crucial requirement, to which the others would have to be geared, was the tide.

It must be rising at the time of the initial landings so that the landing craft could unload and retract without danger of stranding. . . .

Yet the tide had to be low enough that underwater obstacles could be exposed for demolition parties. The final choice was one hour after low tide for the initial landings."

(The Great Sea War, 1960)

Informative effects produced a rapidly rising tide that posed a serious problem for the demolition teams. The uncleared beach obstacles contributed to a loss of momentum among the Allied forces and helped earn Omaha Beach its nickname — "Bloody Omaha."

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Going Further

For those who wish to check our astronomical calculations, the center of Omaha Beach lies near latitude 49° 22' north and longitude 0° 52' west. Allied forces in 1944 used British Double Summer Time, which was Universal Time plus two hours.

A shareware program called Tides is available from Ed Wallner, 32 Barney Hill Rd., Wayland, MA 01778. Running on IBM PC or compatible computers, the program finds times of high and low waters and displays tide height versus time in either tabular or graphical form. Interested readers should send Wallner either the requested $15 shareware contribution or a formatted disk, mailer, and return postage.

The authors are grateful to Wallner and to Margaret Vaverek and Fergus Wood for help in obtaining tidal harmonic constants applicable to Le Havre and Port-en-Bessin.