THE LUCK OF WALTER MUNK

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Walter Munk was the good soldier Schweik of the American Army. He joined the Army in July 1940 and remained for nearly 18 months, in the famous Rainbow Division. Perhaps because of his outstanding leadership ability, he got promoted to be a Scout Corporal. However, this exalted rank lasted for only a few days, when he was reduced to being a private again. It happened in this way:

The duties of a Scout Corporal were to stay with his headquarters unit until the C.O. had selected the site to place the guns. Then the corporal was supposed to go back in a jeep to the place where the guns and other equipment had been parked and lead them in procession to the selected battery site. The first time Walter tried this, he became hopelessly lost, and the guns ended up far from the place they were supposed to be. The C.O. said, "That's O.K., Corporal, everyone gets lost occasionally. Let it be a lesson to you." So, the next time he had this duty, he made careful notes of trees, turnings of the trail and other landmarks so as to remember exactly the way to return with the guns.

However, they came to a cross-roads which was blocked by another unit. Walter, with commendable ingenuity, turned the column of vehicles off the road to speed around the obstacle. Unfortunately the battalion command post had been set up in the woods with drafting tables, telephone lines and other necessary paraphernalia. Walter led his vehicles right through this location, scattering drafting tables, breaking telephone lines, and causing general confusion and chaos. The battalion Commander was so angry that he called up the Captain in charge of Walter's battery and said, "You have to get rid of that corporal right away." For the remainder of his army service, Walter remained a private.

It should be pointed out that in the Army getting lost was apparently S.O.P. Walter remembers one time a few months later when the battalion commander came upon a group of trucks and said, "I thought you were supposed to be following me." The reply came back: "We are following you, sir." The battalion commander had travelled in a circle and had come back on his own men.

He remembers another time when the commanding General of the Rainbow Division talked to the troops. Pointing to his uniform, he asked, "Why is that called a uniform?" Nobody replied, so the General answered his own question, "Because it's got to be *uniform*, that's why." As so often happens with senior officers in peacetime, the General had an obsession about a completely trivial subject. The Rainbow Division started on a long trip from Camp Lewis in Washington to Camp Hunter Liggett near San Simeon in California. The vehicles stretched out over 20 miles — moving a Division is a major operation. Whenever they stopped, word came back from the general leading the convoy about the Uniform of the Day. At first it was blouses without coats, because the general was in sunshine and it was warm. In the rear of the convoy, where Walter was, they were travelling in the shade and it was cold. But they had to follow orders so they took off their coasts and shivered. A few hours later, the General was in the shade and was cold, so the word came back: the Uniform of the Day will be overcoats. In Walter's part of the procession they were now in brilliant sunshine and so they put on their coats and sweltered.

Walter's immediate commander was a fat and brutal Master Sgt. named Ruebush — the kind of man who said, "When the going gets tough, the tough get going," and "The bullet that's going to hit me hasn't been made yet." He loved to embarrass Walter. One way he did this was to put him on the right end of the line when they had target practice. The man on the far left was supposed to say, "Ready on the left, sir," and then Walter was supposed to say, "Ready on the right, sir." As you know, he has never been able to say "R's" very well, so he would say, "Weady on the wight." This pronunciation caused great hilarity among his fellow soldiers, which in turn gave great pleasure to the sergeant.

This tale of the Army ended tragically for Walter's battery, but not for Sgt. Ruebush. Shortly after Pearl Harbor, the battery was sent to the Philippines and was almost completely wiped out by the Japanese. Sgt. Ruebush had gotten himself out of the Army, however, by pointing out that he was too overweight for military service. Fortunately, Harald Sverdrup and I had gotten Walter out about two weeks before Pearl Harbor, because we desperately needed his mathematical ability in the University of California Division of War Research at Point Loma.

Because they were foreign-born and had relatives in occupied Europe, both Walter and Harald Sverdrup had security clearance problems. After a few months, they left us at Point Loma and went to work for an oceanographer named Richard Seiwell who was in the Army Air Corps. Seiwell had learned

that there were going to be amphibious landings, and that one of the problems worrying the "brass" was the possibility of high surf on the landing beaches. Harald and Walter set to work to develop a system for forecasting sea, swell, and surf. This was the origin of H0601 which we saw illustrated yesterday in one of Klaus Hasselmann's slides. H0601 was classified, so that after Harald and Walter had done the work, they were unable to read their own publication because they didn't have security clearances.

I was in a sailor suit at that time as an officer in the Bureau of Ships in Washington. For the rest of World War II, it seemed to me that I spent about two days each month straightening out their security clearance problems, along with those of Alfred Redfield, who had a sister who was suspect. In this task, I was dependent upon the late, great Rawson Bennett, who later became the Chief of Naval Research. Rawson was a big, commanding-looking officer with a fierce glower. About once a month he and I would walk the length of our temporary building, about a third of a mile, to the office of the Bureau of Ships Security Officer. Rawson would glower at this poor man, and Harald and Walter and Alfred would be cleared for another month, until some new Security Officer got into the act. It's ironic to note that Walter is now the darling of the Navy Department and particularly of its most secret part, the so-called Black Navy. It's not everybody for whose birthday the Chief of Naval Research makes a special cross-country trip.

You've Got to be Lucky

During the years of atomic testing in the Marshall Islands, the Scripps Institution was heavily involved in the many phases that concerned oceanography. One of the culminating tests was called IVY, in which a 20-megaton device was to be exploded. This was a thousand times the force of the bombs at Hiroshima and Nagasaki or at Bikini during the "Crossroads" operations. John Isaacs and Walter and I were worried that such a big explosion would cause a large landslide on the steep outer face of the atoll. There was evidence from bottom soundings that such landslides had occurred in the past, and since the Marshall Islands were in an earthquake-free area, we were afraid that the huge explosion might set off another landslide and its accompanying tsunami. We talked the AEC into making special preparations to evacuate the low-lying islands in the central Pacific if a tsunami did occur, and the instrumentation for the tests was mostly set up to be remotely controlled from aircraft, so that ground observers would not be inundated if a tsunami actually happened. This was quite an expensive modification of the AEC's plans.

Bill Bascom and John Isaacs built two wave recorders, which were moored on sea-mounts near Eniwetok, the idea being that these would give virtually instant warning of a tsunami, and the plans for evacuation could then be put into effect. The wave gauges were attached to small rubber rafts, and in each raft there was an old-fashioned Esterline-Angus recorder. Bill Bascom was stationed in one raft and Walter Munk in the other, and our research ship *Horizon* lay to between the two rafts. If either Bill or Walter saw a big signal on their recorder, they were supposed to alert *Horizon*, which would then send a message to the fleet. The explosion went off on schedule. It was a terrible sight which no one who saw it will ever forget, but there was no signal on either recorder. The radioactive cloud came practically over *Horizon*, and it was decided that they must get Walter and Bill off the rafts and move out of there. Two days later, *Horizon* came back to pick up the rafts and the wave gauges. There was a huge signal on Walter's recorder, which had come two minutes after he had left the raft. This, of course, was due to a malfunction of the instrument, but Walter still has nightmares when he remembers it. Suppose he had remained on the raft and had seen the signal, alerted the *Horizon* that a tsunami had occurred, and the whole cumbersome machinery of the island evacuation had been put into motion. He wonders what he would have done, but he thinks he would have simply disappeared from sight and never come to light again. This just goes to prove my favorite motto: You've got to be lucky.

This was not the first time that Walter had spent a good many hours on a small boat. He first appeared at the Scripps Institution in the summer of 1938 when he was 20 years old and I was 29. We had decided to start an undergraduate summer fellowship program, and Walter was our first Summer Fellow. This fellowship program has continued ever since in the hope that it would produce another Walter Munk, but we have never been successful in doing so — perhaps for the obvious reason that Walter is unique.

One of the senior professors at Scripps thought it would be a good idea to obtain a week-long time series of the bottom currents in the submarine canyon off the Scripps pier. This was long before the days of automatic current meters or deep-sea-moored instruments. The currents had to be measured by hand with an Ekman Current Meter, which had to be lowered and raised every time a measurement was made, and we did this from an anchored rowboat. There were three two-man crews, each of which made measurements for about six hours, and then spelled each other off. Walter and I made up one of the three crews. Needless to say, he was a wonderful shipmate — or, rather — boatmate, and we have been together on many enterprises ever since.

By the summer of 1939, he had graduated from Caltech, and he spent a year at Scripps working with Harald Sverdrup on internal waves in the Gulf of California, for which he received the master's degree. Then he enlisted in the army, and I have told you about some of his adventures there.

The Hot Water Problem

It is well known that the range of Walter's research interests is immense. But probably not many of you are aware that he has a special love for plumbing. He claims to have done all the plumbing in his and Judy's house in La Jolla. This plumbing job worked pretty well for more than 20 years until one day about seven or eight years ago they noticed a leak in the tile floor, took up the tiles, and were faced with a small geyser.

Before he started on his plumbing career, Walter spent six weeks on a ranch at Sweetwater, Nevada. Even though it was a healthy, outdoor life, he was bored. His restless mind took up a unique question. The question was: why does it

take so long, after the shower is turned on in the morning, for hot water to appear? He noticed that the water heated up very rapidly, once it began to get warm. This was an ideal subject for a hydrodynamic and thermodynamic model, which he constructed. The result was a paper in the *Journal of Applied Mechanics* under the simple title: "The Delayed Hot Water Problem". This, for all I know, is now a classic of the plumbing sciences.

Why has Walter Munk been able to do so much as an oceanographer? I think there are several reasons. For one, he has always combined observation, theory, and experimentation in a quite remarkable way. Second, most of his work has been done in collaboration with other — often younger — scientists, many of whom were his graduate students or post-doctoral fellows, and he has shown good taste in choosing his collaborators. Third, he has always been open to new ideas and new interests. I used to say that he changed the focus of his activities about once every six months. This was clearly an exaggeration, but it is true that he has worked on many different problems, always contributing new insights and new illumination.

Some of his ideas have come from unusual sources. For example, I am pretty sure that his work on the variations in the speed of Earth's rotation and in the position of the pole of rotation began in a conversation one evening long ago in his office between John Isaacs, Walter and me. We had read a piece in the science fiction magazine, *Astounding Science Fiction*, that talked about Simon Newcomb's "great empirical term". This referred to variations over several decades in the period of the moon's apparent rotation around the earth, which, of course, were due to variations in the speed of the earth's rotation. We speculated that evening that those might be caused by successive increases and decreases in the volume of ice in the Antarctic and Greenland ice caps. Thus began the prize-winning book, written jointly with Gordon MacDonald, in which every aspect of the earth's rotation on a variety of time scales was thoroughly examined. Incidentally, possible changes in the volume of Antarctic ice are again being speculated about, in connection with the carbon dioxide problem.

That book about the earth's rotation has a special meaning for me, because it contained, in a way, my son Bill's first scientific publication. Gordon and Walter sent Bill, at the age of about fifteen, on a summer cruise to the Beaufort Sea, in the Arctic Ocean, where he measured the currents by the old fashioned method of observing a wooden float carried away from an anchored ship. Harold Jeffreys, in *The Earth,* had speculated that the principal source of tidal friction was in the Arctic Ocean, which was rumored to have tidal currents of several knots. Bill found that the wooden float barely drifted away from the ship, and that the current velocities were actually only a few centimeters per second.

There are several other reasons for Walter's extraordinary scientific accomplishments. One is that he is an artist as well as a scientist. He is concerned about the beauty of nature and of natural phenomena as well as the puzzles that nature provides for us, and he writes beautifully about his scientific work. He has remarkable prescience about the problems he works on. They are difficult problems, and hence interesting ones, but problems that are not *so* difficult that at least a partial solution cannot be found.

I have given an example of Walter's luck in telling about the tsunami that never was. But the overwhelming example of his luck is in having Judy for a wife — that cheerful, helpful, creative, loving woman, always full of ideas and projects, always ready for anything that needs to be done, gently steering and inspiring her man, in an almost unnoticeable way. If Walter Munk had never done any great scientific work, his life as a husband, a father, and a friend would still be an inspiration for the rest of us.