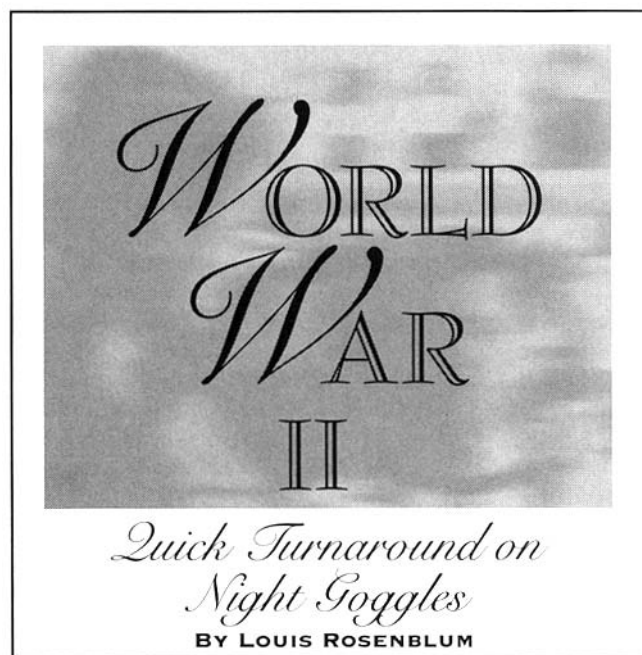


Edwin Land had a flair for solving complex problems. He enjoyed creating elegant and inexpensive devices, in remarkably short times and at modest development prices, for a wide range of military problems in World War II. From 1940 until the end of 1945, the Polaroid Corp. concentrated almost all of its research, engineering, and manufacturing operations on products used by the Navy, Army, Air Corps, Marine Corps, Coast Guard, and their counterparts in the Allied Military Forces. One of Land's many rapid response inventions—special night goggles—made it possible for Navy fighters and bombers to land safely at night on aircraft carriers in the Western Pacific. The pilots landed with essentially no visible light so that lurking *kamikaze* pilots could not see the carriers and destroy them in a raid.

In late September 1944 the Navy Department sent Lt. Cmdr. Robert Peckham to Cambridge with orders to arrange for an urgent development program. The problem was to find a plastic filter material that would absorb all of the ultraviolet light emitted by a mercury vapor spotlight, would not fluoresce, would transmit as much visible light as possible, and would be stable under the heat, brilliant sunlight, humidity, salt air, and other harsh conditions of the tropical regions of the Western Pacific. When Peckham completed his description of the requirements and of the many kinds of glass and plastic filter materials that had been tried and found inappropriate, Land said that a recently synthesized dye could be used to produce non-polarizing plastic film that should be suitable. This thin film could be laminated between clear plastic sheets, die-cut into goggle filters, and assembled into the aviator's molded rubber goggles that Polaroid had been manufacturing for aircraft, shipboard, battle tank, and desert warfare troops.

Land had probably known about the proposed system of outfitting each Landing Signal Officer (LSO) with bright fluorescent cloth strips on his clothing and signal torches. With an ultraviolet emitting spotlight, filtered so that very little visible light could be detected even when looking directly at it, the incoming pilots could see the LSO signals that would enable them to approach the carrier at the correct speed and rate of descent for a safe quick landing. The landing area was outlined with recessed dim blue lights that could only be seen from a short distance above the deck, during the last 10 to 15 seconds of the pilot's approach. The difficulty with this system, however, was that the ultraviolet light caused the lenses of an LSO's eyes to fluoresce so intensely that he could not see the incoming airplane and,



therefore, could not use the standard arm signals to direct the pilot.

When it was apparent that the sample filter that Land handed to Peckham was a likely solution, Land asked how many sets of goggles were required. Peckham replied that a few dozen, or perhaps as many as 50, would make an enormous difference for the most critical carrier night-landing patrols. Land then asked how many might be needed for all carriers involved in night operations

in enemy waters. Peckham thought for a few moments and suggested that 200 sets might be sufficient for all of the officers on both the large carriers and the baby flat-tops that were equipped or could be equipped with the ultraviolet spotlights.

Land's next question to Peckham was the length of stay specified in his travel orders. Peckham replied that his two-day orders could probably be changed by a telephone call to Washington. He asked if three or four days might be required to write the detailed specifications, examine the laboratory test data, and prepare a demonstration. Land's next suggestion was that if Peckham could arrange to have his travel orders changed to a week, he could go back to Washington with the total requirement of goggles ready to airlift to the fleet, and with much less paperwork.

It took Peckham less than a minute to recover his aplomb and to ask if Land was serious. At that point Land turned to me, asking if I could make the necessary calls to the appropriate production, purchasing, and quality control groups. As soon as I said, "Yes," Land stood up and said "Okay, do it, but be sure not to neglect your other quality control duties." As Peckham and I started to walk out of the fifth floor corner office of 730 Main Street, Land added, "If you run into any technical or organizational problems just leave word with Mrs. Billings, my secretary." As we approached the top of the stairs he came out of his office and added with a twinkle in his eyes, "Try not to ruffle too many feathers."

The meeting had taken about half an hour and was a little surprising to me since I was not yet 23 years old and had become acting manager of quality control only a few months earlier (when my predecessor had disappeared almost completely into Polaroid's Top Secret guided missile project). The events of the next hours and days were one of the many demonstrations of the kind of flexible, enthusiastic company that Land had created to carry out the large and varied invention-to production-to delivery cycles that were possible in the unique company of people that he had gathered around him.

GOGGLE PRODUCTION

Peckham and I went down one floor to the lab where I knew there was a mercury vapor lamp, the weathering and other accelerated aging machines, the spectrophotometer, and the records of previous tests. We spent more than an hour viewing fluorescent materials with the ultraviolet lamp, simulating rather crudely in a darkened room the rapidly approaching low-power landing lights of an airplane moving behind the UV lamp, and looking at the assembled test data. After repeatedly warning me not to look at the UV lamp without a filter in front of my eyes, Peckham then suggested that I close my eyes, remove my eyeglasses and then look at the UV lamp for a very brief moment. As I followed his instructions, I suddenly sensed how very serious the problem was for every LSO. Peckham had noticed that the rather thick lenses I wore (for serious myopia) were tinted and so were probably transmitting no more than 20% of the 365 nm energy from the lamp. The five-time increase in UV for just a few seconds made my eyes extremely uncomfortable.

Peckham was elated. He decided that the filter would meet the Navy's requirement and so called his office in Washington to ask his superior for an extension of his travel orders—for one week with the possibility of a second week—and for a purchase order number that would be confirmed by a telegram. I do not recall the mention of any price per set of goggles or total dollar commitment by the Navy, but the amount Peckham was given verbal authorization to spend was clearly enough to get started on the internal production and external purchase orders.

Immediately after lunch on the first day of Peckham's stay, we sat down with Polaroid's one-woman Order Department to work out the orders for unpolarized plastic film with the new dye, for laminating the film between optical grade clear plastic sheets, for covering the laminate with pre-cut paper so that the material would not be scratched during the die-stamp marking, grommet installation, and

then insertion in the molded rubber goggles. A marking die was ordered (by telephone) from the local supplier of such items and extra goggles were ordered by telephone from Acushnet Process Co. in New Bedford (to replace those that would be diverted from the 25,000 that arrived every week for the several other goggle programs).

It was essential to have each of the XY91UV0 filters marked so that the LSO could readily differentiate it from the XC92 clear goggle lenses that were routinely used by flyers on overcast days.

To minimize any possible delay that might be caused by less-relevant details, Peckham volunteered to write and

have printed in Washington the special instruction sheet. And it was agreed that for this small quantity the LSO goggles would use the standard Navy rugged reinforced cardboard boxes that were being used for Navy N-2 goggles.

We spent the rest of the afternoon of the first day talking with each of the department managers who would be involved and with the outside suppliers to alert them to the new production order, to find out how soon they could fit it into their schedules, and to find out if they would like to have Peckham (in dress uniform) explain to their production workers the urgency of the requirement.

Peckham's visits to many of the departments and to the already ample Polaroid library were my mechanism 'so that I

could get back to the other responsibilities that could not be deferred during this small but urgent perturbation in the routine six-days-a-week operations of the company. By the end of the week the several hundred square feet of plastic film had been manufactured and most of it had been laminated between selected sheets of clear acetate.

Peckham was so effective in generating enthusiasm for the project that I decided to accompany him to the Jamaica Plain building where the goggle lens blanking, marking, assembly, paper removal, inspection, and packaging operations were located. One of the planned sub-tasks was to



Figure 1. A military pilot wearing the N-2/B-8 Goggles.

Courtesy of Polaroid Archives.

determine how large a bundle of goggle boxes could be tied together and carried by Peckham (who was a six-footer and had unusually long arms) under each arm. I recall that we found that he could lift and walk about 100 feet with a bundle of 25 filled boxes under each arm.

Of great concern was the number of striation blemishes in the hastily laminated sheets. The production and quality control supervisors agreed to Peckham's suggestion that we set aside the worst sheets (an overrun of about 30% had been made to allow for such contingencies) and then run the rest of the material with the understanding that the assembled goggles would require a more extensive than usual and, perhaps, 100% inspection so as to eliminate the lenses with intolerable blemishes. Peckham's now well-rehearsed talk about the use of these special night goggles for Landing Signal Officers and of their importance to the safe landing of Navy pilots was sufficient so that the extra work was accomplished with only a small delay in the

Washington with his collection of two bundles, several large cartons, and his overnight suitcase. Sets of goggles were routinely shipped in large cartons because the individual protective boxes with the goggles weighed just nine ounces.

In a call the next day, Peckham told me that several senior officers had made a special point of calling Mr. Land to express their enthusiastic thanks for the elegant and rapid response to the request for a development program. In the following weeks it was our understanding that the LSO Goggles, in standard issue boxes labeled "STOCK NO. 37-G-3050 GOGGLE, N-2 (All Purpose) QUANTITY 1" were airlifted to each of the more than a dozen large aircraft carriers and the several score baby flat-tops in the Pacific. We assumed that they arrived in time for the massive October 1944 Leyte Gulf air battle in the Philippines, and were routinely used off Iwo Jima and Okinawa in early 1945.

During the war, Polaroid had shipped scores, maybe even hundreds, of different Vectograph stereoscopic photo systems, optical instruments, goggle sets, precision glass filters, and cast plastic optical elements. Most of these were either unique products invented by Edwin Land or were production quantities of optical devices that had never before been made either in large quantity or at such low prices. Only those devices that had a postwar non-military market were continued. The other projects were closed down as rapidly as possible. A few were sold to companies that had a continuing interest in military sales. The inventories of finished goods and saleable raw materials were sold through surplus channels.

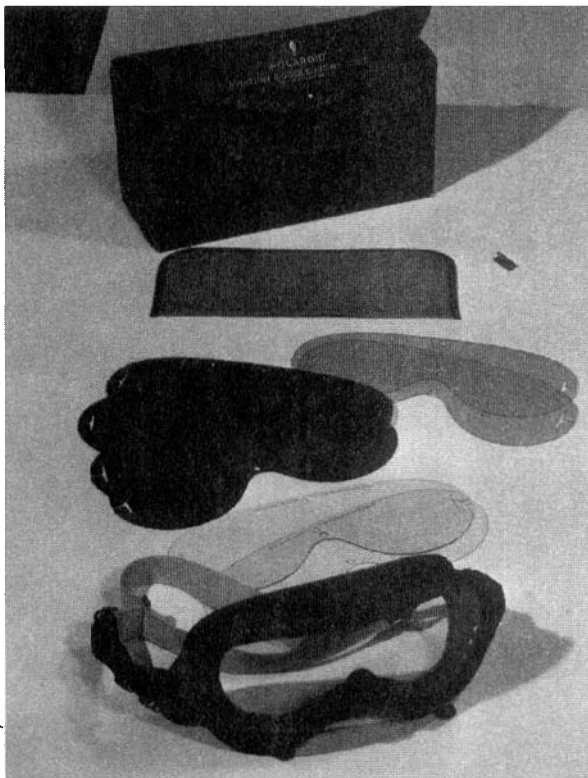
In a box in my basement with the XY91UV0 Goggles was a very dense unmarked B-8 size filter accompanied by a printed piece of paper carrying the following: GENERAL PURPOSE N-2 GOGGLE, With Special I.R. & U.V. Absorbing Lens (N D 4.5). I had acquired this filter before February 1945 and had no record about the military purpose of a 4.5 neutral density goggle filter. Could it have been a special item used for spotting a *kamikaze* pilot diving with the sun behind him? This hardly seems likely because the filter is so dark that each of our pilots would have had to remove his goggles if he wished to see in any direction other than directly at the sun.

More likely this filter was manufactured for yet another special order goggle, one perhaps for viewing the "brightness of a thousand suns . . ." Edwin Land's insights and Polaroid's production facilities provided the gamut from clear goggles for night use to dark goggles for *very, very* bright occasions.

Note:

If a reader of this article has or recalls seeing one of the LSO Goggles or one of the Density 4.5 Goggles, the Polaroid Archives Curator, Ms. Nasrin Rohani, and I would welcome receiving any additional information.

LOUIS ROSENBLUM, OSA Member Emeritus, is a consulting engineer specializing in high performance photographic systems and, in recent years, in the design of typographic fonts for Cyrillic, Greek, and several other non-Latin writing forms. He was quality control manager and then an engineering manager of the Polaroid Corporation during and after World War II. He lives in Belmont, Mass. and can be reached at 617/484-9005.



Courtesy of Polaroid Archives.

Figure 2. The contents of the Air Corps Kit #1068. There were eight different filters in this kit.

usual assembly. That operation had dozens of women whose routine throughput may have been on the order of 4000 sets of goggles a day.

DELIVERY

The additional inspections made the planned one week delivery impossible and so it was not until the middle of the second week that Peckham was installed in a parlor car on the Federal Express overnight train to Washington. He decided that the shipment was too important to go by checked baggage and so acquired a retinue of porters to help him get on the train in South Station and to get off in