obtained on the *Maud*. He was entrusted with the preparation of those parts of the report on the results of the *Carnegie* expedition in 1928 and 1929 that deal with dynamical oceanography and other physical and chemical aspects of the sea. While these reports were in preparation he was in Washington for some time. He was one of the advisers for the National Academy Committee on Oceanography and went to Woods Hole during the summer of 1928 and spent some time with the members of the committee. I well remember the pleasure I felt when my wife and I reached Bergen in October, 1932, and Sverdrup was standing on the pier to welcome us. Our first meal in Norway was in his house. Numbers of Americans not only know Sverdrup's scientific work, but have an intimate personal acquaintance with him. He is a man of the finest character in every way, who has made friends with every one in this country who has had the good fortune to know him.

Mr. President, in presenting the Agassiz Medal to Harald Ulric Sverdrup you give worthy recognition to scientific achievement of a very high order of merit and give pleasure to the friends of a man who has endeared himself to many in this country.

T. WAYLAND VAUGHAN

RESPONSE BY THE MEDALIST

I WISH to express my deep appreciation of the honor which has been bestowed upon me by the award of the Agassiz Medal for contributions to oceanographic research. It makes me especially happy that the award has been made by the National Academy of Sciences of the United States, because it has been my good fortune to be associated with American institutions since my very first contacts with scientific work. As a graduate student I became in 1911 research assistant to Professor Vilhelm Bjerknes, who, thanks to a grant from the Carnegie Institution of Washington, was able to start young men on scientific careers. Thus, at that time I was already indirectly connected with that institution, which later on cooperated with the *Maud* Expedition, and of which I have been a research associate since 1928. Through my contact with the Carnegie Institution I have made friends in this country, and it is thanks to these friends that I now can take pride in being a member of the faculty of the University of California.

Dr. Vaughan has said too many kind words about my contributions. It is a somewhat doubtful pleasure to listen to a review of one's own merits, but for reasons which I should like to explain I am glad that Dr. Vaughan mentioned my work in the Arctic. Certain mental hardships of scientific Arctic exploration are rarely discussed. I am thinking of the feelings of uncertainty which often arise and which can not be dispelled because there is no adequate literature available for reference and no possibility for discussion with men of similar interest. On the *Maud* we started new investigations, we built new instruments, and I spent considerable time in theoretical studies of tidal currents. Although there were periods when I was so completely absorbed in the work that weeks and months passed quickly, there were other periods when I wondered and worried for fear I had made some elementary mistake, for fear the new investigations were suffering from systematic errors, for fear our new instruments did not perform as they should or that my theories were unsound. In such periods there was no one to consult, no literature to look up. Thinking back now I find myself again walking the deck of our vessel, turning the questions over in my mind, trying to find some flaw in my reasoning. In the end I always had to tell myself that, right or wrong, I was doing my best and would have to go on doing so, hoping that I was on the right track. Perhaps you will understand that an occasion like this brings ample compensation for all the hours of worry and uncertainty.

There is another matter I wish to mention to you. During the last winter in the Arctic, in 1924–25, we used to discuss what we wanted to do after returning to civilization. One of our party wanted to go to Peru, cross the Andes and, instead of drifting with the ice, to drift down the Amazon River on a raft. He did. I used to say that I should like an opportunity to do oceanographic work in the Pacific Ocean. It took me much longer to reach that goal. Although in 1930 I came into intimate contact with the problems of the Pacific through discussion of the excellent data collected by the *Carnegie,* it is only within the last three years that my wish has been actually fulfilled. In 1924–25 I thought of the Pacific Ocean as a pleasant contrast to the Arctic; now I am more than ever impressed by the tremendous amount of work as yet to be done in the Pacific Ocean, and by the fact that, in spite of the pioneering of Alexander Agassiz and Sir John Murray, large areas in the Pacific Ocean are still completely unknown from the point of view of the oceanographer. This fact has again and again been emphasized by Dr. Vaughan, who during his years as director of the Scripps Institution of Oceanography, greatly stimulated the interest in the exploration of the Pacific.

The Scripps Institution has a fortunate location and adequate resources for intensive studies of limited areas off the coast. While it can attack some of the many problems of the Pacific, a general exploration of the Pacific Ocean is an undertaking of such dimensions that no single institution can contemplate it.

Recently, Great Britain honored the memory of Sir John Murray by a "John Murray Expedition" to the Indian Ocean. It appears to me that the best manner in which the United States can honor the memory of Alexander Agassiz will be to organize a large-scale Alexander Agassiz Expedition for exploration of the Pacific Ocean.

HARALD ULRIK SVERDRUP

THE CHANGING OUTLOOK OF ENGINEERING SCIENCE[1]

By Professor R. V. SOUTHWELL

PROFESSOR OF ENGINEERING SCIENCE, UNIVERSITY OF OXFORD

BRIEFLY, here too my thesis is that we should avoid undue humility! The times are out of joint, and having attained to command of nature greater than the world has seen before, because man has not learned to use his mastery wisely, illogically now (as it seems to me) he inclines to question the value of that mastery, and the labors that have given it. In particular I want to record my protest against what seems to be an implication in much that is written nowadays, that because the range of engineering includes guns, battleships, aeroplanes, tanks, therefore engineers are to be regarded as a class more than others responsible for the horrors of modern war.

Here are words spoken by Sir Alfred Ewing, in a presidential address to the association (1932) which I keep to read ever and again, for its showing of what at the best an engineer's outlook may be:

> An old exponent of applied mechanics may be forgiven if he expresses something of the disillusion with which, now standing aside, he watches the sweeping pageant of discovery and invention in which he used to take unbounded delight. It is impossible not to ask, Whither does this tremendous procession tend? What, after all, is its goal? . . .
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> The cornucopia of the engineer has been shaken over all the earth, scattering everywhere an endowment of previously unpossessed and unimagined capacities and powers. Beyond question many of these gifts are benefits to man, making life fuller, wider, healthier, richer in comforts and interests and in such happiness as material things can promote. But we are acutely aware that the engineer's gifts have been and may be grievously abused. In some there is potential tragedy as well as present burden. Man was ethically unprepared for so great a bounty. . . . The command of Nature has been put into his hands before he knows how to command himself.

Here too are words spoken somewhat earlier, in his wonderful James Forrest Lecture, 1928, on "A Century of Inventions." In them still more clearly, as I read them, he seems to feel as engineer a sense of special responsibility:

> I used, as a young teacher, to think that the splendid march of discovery and invention, with its penetration of the secrets of Nature, its consciousness of power, its absorbing mental interest, its unlimited possibilities of benefit, was in fact accomplishing some betterment of the character of man. . . . But the war came, and I realized the moral failure of applied mechanics. . . . We had put into the hand of civilization a weapon far deadlier than the weapons of barbarism, and there was nothing to stay her hand. Civilization, in fact, turned the weapon upon herself. The arts of the engineer had indeed been effectively learnt, but they had not changed man's soul. . . .
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> Surely it is for the engineer as much as any man to pray for a spiritual awakening, to strive after such a growth of sanity as will prevent the gross misuse of his good gifts. For it is the engineer who, in the course of his labors to promote the comfort and convenience of man, has put into man's unchecked and careless hand a monstrous potentiality of ruin.

To which I personally would answer: "Yes, for the engineer as much as any man, *but no more.*" And when, in more recent pronouncements, I find the charge so glibly formulated—"It is engineers who have given men these potent weapons of destruction: on them *more than others,* then, rests the responsibility for their use"—then, admitting the premise, I protest against the deduction. I would say rather: "On them as much as on others (but no more) rests the responsibility for their use." Do not think that I imagine the load thus shared will be light for all. I have no illusion about the weight of responsibility—it is appalling; but I hold that we must share it equally, as citizens, not look for scapegoats when we have been free either to choose our path or leaders to direct us.

I can conceive no subject in which, more than this, clear thinking is wanted to-day: the desire to hand on responsibility is so deep-seated, and the will to believe that we could have had the benefits of science without its risks and its temptations. But knowledge is of good and evil: it is of its essence that we can not know how to cure poison without knowing poison and its action, how to control and use explosives without acquiring power for harm as well as good. We may elect either to shun it or pursue, but we can not have it both ways. Either we must choose, deliberately, impotence as preferable to the power of doing evil, or we must accept knowledge for the double-edged tool it is, vowing to use it wisely. We may not say to the scien-

[1] The concluding portion of the address of the president of the Section for Engineering of the British Association for the Advancement of Science, Cambridge, 1938.