along with subjects in hydraulic engineering. Now in addition to the traditional role we must be much broader, studying ecology, biology, resource management, a smattering of systems analysis, and related items plus humanities and social science. Although every engineering curriculum contains these latter two items, they are loosely required with only the vaguest of goals and no thoughts toward the unity of knowledge in the sense of Wilson (1998). In other words, the modern hydraulic engineer must be able to speak ‘‘ecology’’ in the broadest sense of the word. We must be team players with a variety of disciplines. To be part of a team, courses in the language and culture of ecology, biology, economics, social studies, and the humanities have to be a part of the education, including the continuing education of hydraulic engineers (Liggett and Ettema 2001). Our universities must do a better job of integrating disciplines—of consilience—than they have up to the present. Courses in these subjects should not be individual and unconnected hurdles on the path to a degree (Ettema 2000).

However, this approach contains its own hazards. ‘‘Environmentalist’’ is all too often a buzzword and signifies someone who cares about the environment but knows little science or engineering and is likely to embrace the latest ‘‘green’’ fad. One who calls him/herself an environmentalist is frequently regarded as a refugee from academia who cannot make it in science or engineering. Thus, the educational requirements for hydraulic engineers should not be relaxed. *No one should be able to call him/herself a hydraulic engineer until he/she has mastered the science, mathematics, mechanics, and engineering*. When dealing with environmental issues we must speak from a solid background, not repeat the dogma of the Sierra Club or other groups. Although the position of such groups often stems from expert knowledge and is the best that we know at the time, it is too often a knee-jerk reaction of those who seem to believe that everything man-made, especially a large engineering project, is bad.

A New Time of Hydraulic Engineering

The challenges of hydraulic engineering of the last half century remain. They can be stated as familiar questions: How can we better predict and calculate sediment transport? ice effects? open channel hydraulics? water supply for irrigation and municipalities? groundwater flow and groundwater remediation? How can we better link hydraulics, hydrology, and weather forecasting? How can we better characterize turbulence so that it does not defeat our calculations of diffusion, boundary friction, transport, and fluid flow in general? How can we better use computational fluid mechanics to study the complex problems that nature has given the hydraulic engineer? How can we design better and more efficient structures? All these questions and more are crucial not only to the traditional role of hydraulic engineers, but also to our emerging responsibility as a partner in society’s decisions for what is best for sustaining human development and environmental well being.

Only if we remain knowledgeable in these matters can we enter the debate as experts on specific questions such as: Should Bridge Canyon Dam be built? Should Glen Canyon Dam be removed? Should the Snake River Dams be removed? Should flood control projects be constructed with higher dikes and levees or should we restore flood plains and marshes for relief? And we should provide expertise on mankind’s role in preserving nature while attempting to provide a decent standard of living for the people of an overpopulated earth. Hydraulic engineering must go far beyond the realm of applied fluid mechanics while retaining a base deeply rooted in fluid mechanics. These questions (and those regarding less developed countries, only briefly mentioned herein) can be answered only by the consilience of hydraulic engineering with the humanities and social sciences while being especially careful to maintain the quality and integrity of hydraulic engineering. Such a goal may be as difficult as the characterization of turbulence, but it is as important.

The challenges of the twenty-first century may not contain the same machismo of the twentieth century, but they are certainly as important and even more challenging. It is still a great profession!

Parting Comments

In an attempt to address its title question, this paper considers the role of hydraulic engineering in the development of large water-control projects in the twentieth century. Although the dams associated with those projects are symbolic, highly visible, useful, and sometimes controversial, they are, of course, only a part of hydraulic engineering activities. This paper also is largely about hydraulic engineering in the United States. The development of large water projects, including dams, continues in many other countries and in some cases appears essential to their development. Attitudes and conditions in many countries may differ considerably from those in the United States; therefore, it is not appropriate to judge them in the light of the United States experience. The account given in this work is intended to be broad—and intended to make the point that our profession is becoming broader—in terms of hydraulic engineering’s place amidst human endeavors. Obviously, no one answer to the title question is entirely satisfactory. Readers should apply their own perspectives and answers to that question.

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Appendix

Notes

Economics and War. Of course, many other projects contributed to the war effort and the economic development of the west. The United States was especially fortunate to have the huge electrical resources of the Columbia River come on line with the completion of Grand Coulee at the beginning of the war. Power from Grand Coulee and other Columbia River dams supplied the bauxite furnaces that were a cornerstone in aircraft production. The United States may have won the war without Grand Coulee, Hoover, and Bonneville, but it would have been a longer war with more casualties. An extensive (211 pages plus annexes) analysis of the project can be found in Ortolano et al. (2000). They study