COPING WITH THE DEMANDS OF THE 21ST CENTURY

“Look to the future, because that’s where you’ll spend the rest of your life.”

— George Burns, American Comedian

Recently I found myself reflecting with a young Schnabel engineer on how different the world was when my career started. The Texas Instruments SR-10 handheld calculator was a hot commodity. In 1972, when it was introduced, it initially sold for $150 (Harvard tuition was $2,800 per year). The SR-10 was worth it to those who could afford it. After all, it did solve square roots! I kept a slide rule on my belt for quite a while longer. Within a decade, solar powered handheld calculators with many more functions could be had for less than $20.

In the 1970s, we’d find the centroid of a drainage area by balancing a cardboard cutout across an engineer’s scale, marking the balance line and turning 90 degrees to lock in the centroid location along that line. With GIS, we can locate a point of interest and click to define the contributing drainage boundary. The centroid, drainage area, average basin slope, and numerous other parameters can also be made to appear, as if by magic.

The critical difference between then and now is that timelines have been so compressed that we have lost the luxury of deliberation. “Back in the day,” almost all analyses were done with pencil on paper or by submitting a deck of punched cards to be fed into a massive computer that eventually spewed out green and white 11” by 17” sheets with perforated edges. Because more of our time was spent performing mechanical duties, we had time to think things through as we worked. E-mail, fax machines, and FedEx hadn’t been invented, so one could always buy at least one day’s delay in mailing off a work product. That additional time was incredibly valuable for allowing validation of both the accuracy and the astuteness of responses to our clients.

If you are reading this newsletter, your job likely entails thinking and acting based on information flow; processing that flow and adding value to it; collaborating with others; and applying logical mental processes to create findings and draw conclusions. Most of those critical processes are not intuitive (the answer can’t be divined from the question). Many also benefit from opportunities to thoughtfully contemplate ambivalent or sticky issues in making decisions, because complex processing significantly benefits from deliberation and reflection.

In the second decade of the 21st century, things have sped up tremendously. This means we have to be, or at the least be prepared to be, intently focused at a moment’s notice. Many to whom we are accountable (clients, supervisors, regulators, etc.) place demands on us for immediate action — because technology allows it. Familiar? Many of us do the same to those that report to us.

This places incredible responsibilities on us and the people we work with, and that translates to a need to surround ourselves with people that get it right – virtually all the time. Demands of the 21st century workplace are well-stated in a quote from Ken Robinson (below).

“Needed: People who are literate, numerate, who can analyze information and ideas; who can generate new ideas of their own and help to implement them; who can communicate clearly; and work well with other people.”


The US now ranks 28th in the world in mathematics, 18th in reading, and 22nd in science. A recent poll shows that 1 in 4 Americans don’t know the Earth revolves around the Sun. Embarrassing! To elevate education, it needs to be reinvented and reinvigorated. The musings of a panel of experts serving a federal bureaucracy won’t make this happen. It’s more likely to occur when the needs of the workplace become so poorly served that employers provide sufficient pushback to make it happen. I believe that the time is here, and we need a grassroots pushback to instigate an education rebirth.

Join me in working to achieve higher levels of performance from ourselves, our coworkers, our children, and our education systems. Our futures depend on it.

1 I recommend www.TED.com – search for “Ken Robinson.” You will be educated, entertained, and enlightened by videos from Sir Ken and many others.
Larger conduits can be inspected by manned-entry, assuming proper OSHA precautions are taken. For smaller pipes, specialized inspection services are required. Often video equipment, mounted on remotely operated vehicles (ROV), is utilized to document the inspection.

Regardless of the method of inspection, a conduit inspection should focus on identifying deterioration, settlement, offset or open joints, and seepage zones. Since each dam site will have a somewhat unique conduit and gate configuration, the inspection should be thoughtfully planned prior to mobilizing the inspection team. If possible, the inspection should be performed after the dam is put into service to assess the conduit’s condition and performance.

Conduits are typically constructed through embankment dams out of necessity — to safely convey water through the dam. Given that penetrations through dams are a leading failure mode, an outlet conduit demands careful attention during design and construction as it creates a discontinuous zone in the embankment. Additionally, inspections of outlet conduits should be periodically performed after the dam is put into service to assess the conduit’s condition and performance.

For additional information on outlet conduits, refer to “Under Pressure: Aging Outlet Conduits” co-authored by Jeremy Young and John Harrison of Schnabel, along with Tyson Clouser and Tony Nokovich of the Pennsylvania American Water Company.

Tuberculation is an encrustation of corrosion byproduct and mineral deposits that form on the inside of iron pipes. The interior of the pipe may be covered with up to several inches of tuberculation which, in addition to impeding an inspection, can significantly reduce the hydraulic capacity of the conduit.

An effective inspection of an outlet conduit may require that the pipe walls be cleaned. However, as with developing the inspection plan, careful consideration should be given to selecting an appropriate cleaning technique before proceeding to avoid causing additional damage to the conduit.

Consideration should be given to sliplining metal conduits after abrasive cleaning since tuberculation will be removed and the exposed bare metal will be susceptible to an accelerated rate of corrosion.

Even with a dewatered conduit, tuberculation can obscure the pipe walls from inspection. Tuberculation is an encrustation of corrosion byproduct and mineral deposits that form on the inside of iron pipes. The interior of the pipe may be covered with up to several inches of tuberculation which, in addition to impeding an inspection, can significantly reduce the hydraulic capacity of the conduit.
Schnabel has in-house capability and expertise for performing Computational Fluid Dynamics (CFD) modeling, using FLOW-3D by Flow Science, and has purchased a new high performance work station dedicated to its use.

Flow-3D simulates fluid flow by using advanced numerical methods and robust algorithms to solve hydraulics problems in three dimensions and over time. The powerful visualization capabilities of FLOW 3-D, with its new rendering software Flow Sight, can be used to develop striking images and animations that present tangible visualizations and interpret engineering issues. FLOW 3-D models of hydraulic structures and of river reaches have proven to be effective tools for reducing both hydraulic risks and overall project costs: a win-win for clients and for us.

Flow patterns, pressures, velocities, and water-surface profiles from FLOW 3-D provide insights and design information to reduce design conservatism.

FLOW 3-D can be combined with physical modeling to take advantage of the strengths of each model type. FLOW 3-D can be used to rehabilitate a spillway, restore habitat in a river, or analyze dam breach inundation impacts.

Schnabel does not limit FLOW 3-D to project assignments. We regularly team with researchers to develop new insights and design advances to elevate the state of practice. We have collaborated with multiple universities to study the complex hydraulics of labyrinth spillways and PK weirs: a part of our dedication to working with world-class expertise to advance engineering practice. For further information, please contact dams@schnabel-eng.com.