Richard M. Iverson

KIRK BRYAN AWARD

Presented to Richard M. Iverson

Citation by Gary A. Smith and John E. Costa

Iowa is not a location well known for the study of debris flows or other forms of rapid mass movements. But Iowa was the home and Iowa State University was the site of the undergraduate education of the scientist who has probably made the greatest contribution to understanding the dynamics of debris flows, which are among the deadliest and costliest of processes studied by geomorphologists. Dick Iverson went on to complete two M.S. degrees and a Ph.D. in applied earth sciences at Stanford University in 1984. His training was outstanding, and his intellect even more so. Nurtured in the wake of the unprecedented size and variety of mass flow processes associated with the May 1980 eruption of Mount St. Helens, Washington, Dick initiated a U.S. Geological Survey (USGS) research program to understand the linkage between the sedimentological and geomorphological field expressions of huge debris avalanches and debris flows, and the physical processes that could produce these features. For this, Dick needed careful field observations, theoretical models that linked soil mechanics and fluid mechanics, small-scale laboratory and field experiments, and eventually, controlled, field-scale laboratory experiments in which a variety of parameters could be systematically altered. He accomplished all of these, and the outcome is the paper we honor today.

Regrettably, many geologists approach their field research qualitatively and without rigorous physical understanding of the processes they study. Dick has worked hard to change traditional textbook views. "Physics of Debris Flows" is a landmark contribution to the field and a testimony to his grasp of fluid and solid dynamics and cleverness as a field-scale experimentalist. Dick has combined observations of active flows, study of resulting deposits, thorough consideration of relevant theoretical arguments, and experiments in diverse fields (including those far removed from earth science) to modernize and quantify what debris flows are, how they move, and how they deposit their load. Key to his studies was the establishment of the USGS field-scale debris-flow flume in the H.J. Andrews Experimental Forest, near Blue River, Oregon. Experiments there by Dick and colleagues have substantially expanded understanding of debris-flow initiation, dynamics, transport, and deposition, and identification of the critical variables affecting these phenomena.

"Physics of Debris Flows" is drawn substantially from Dick's own work as well as being a remarkable and succinct integration of relevant theoretical and experimental results reported by other researchers. He has separated wheat from chaff while explaining the merits of the former and weaknesses of the latter, and he has integrated diverse results into coherent pictures without simplifying debris-flow processes. Most important, Dick developed a new, simple model for debris-flow motion that will serve as a foundation for future developments. His approach recognizes the need to account for both solid and fluid forces, whereas past models have emphasized one or the other.

Dick Iverson's "Physics of Debris Flows" is worthy of the Kirk Bryan Award for several reasons: It is remarkably well written, despite being quantitatively rigorous and astonishingly wide in breadth, and presents a new model for debris-flow motion; it emphasizes the need for surficial geologists to understand the link between field observation and the quantifiable underlying physical basis for the observed processes; and it substantially advances our understanding and focuses future research objectives regarding debris flows—a dynamic surficial process that is both threatening as a hazard and important to interpreting many aspects of past environments.

Response by Richard M. Iverson

Thank you, John and Gary, for your kind citation. I feel very fortunate to have my work honored in this way. Four factors served as catalysts for studying debris flows and building the USGS debris-flow flume. One was a widely perceived need for improved mathematical models of debris flows and for data to motivate and test such models. Another was a legacy of frustration wrought by numerous attempts to collect high-resolution, real-time data in the field. (These attempts revealed that natural debris flows have an alarming appetite for electronic instrumentation, consumed either plain or garnished with cables and data loggers.) The third catalyst was my participation in controlled, large-scale landslide experiments in Japan—an experience that prompted dreams of similarly controlled experiments with debris flows. The fourth was the presence of two key people. John Costa, my boss in 1988 when I formally proposed the debris-flow flume, provided unwavering support that was crucial because enthusiasm for the project was not universal. Rick LaHusen participated in the flume project from its earliest stages, and his electromechanical wizardry turned my sometimes harebrained ideas into functional measurement systems.

The good fortune that propelled the flume project reminds me of a quote written on a card I've kept on my desk for 15 years: "Concerning all acts of initiative and creation, there is one elementary truth, the ignorance of which kills countless ideas and splendid plans: that the moment one definitely commits, then providence moves, too. All sorts of things occur to help one that would never otherwise have occurred. A whole stream of events issues from the decision, raising in one's favor all manner of unforeseen incidents, meetings and material assistance which no man could have dreamed would have come his way. Whatever you do or dream you can, begin it. Boldness has genius, power, and magic in it. Begin it now."

This quote is commonly attributed to Johann Goethe (1749–1832), although scholars of German literature caution that Goethe's authorship is not an unequivocal fact. In any event, Goethe was not only a fine writer but also a geologist and physicist, and I favor the hypothesis that he both wrote this passage and had scientists in mind at the time.

That brings me to a second topic, which is the linkage between geomorphology and science in general. Geomorphology is nearly unique among geological sciences because it deals mostly with phenomena that are accessible to direct measurements and manipulative experiments. Furthermore, the conservation laws of classical physics provide a solid framework for building and testing geomorphological models.

Why apply classical physics to geomorphology? It's admittedly difficult to abstract geomorphic phenomena in experiments and formalize them with mathematics, and such efforts might be viewed as unnecessary if inferences about the origin of landforms are the ultimate goal. In my view, a further goal of geomorphology is to structure our knowledge of Earth's surface within the framework of physical laws that govern all natural phenomena. Such structuring is possible because, in the words of Richard Feynman (1918–1988), "Nature uses only the longest threads to weave her patterns, so each small piece of her fabric reveals the organization of the entire tapestry." Geomorphology examines one small piece of the fabric of nature, and within geomorphology experiments and models of debris flows have a modest aim: to gain a clear view of a thread or two that connects with a greater whole. Thank you for honoring this type of work with the Kirk Bryan Award.