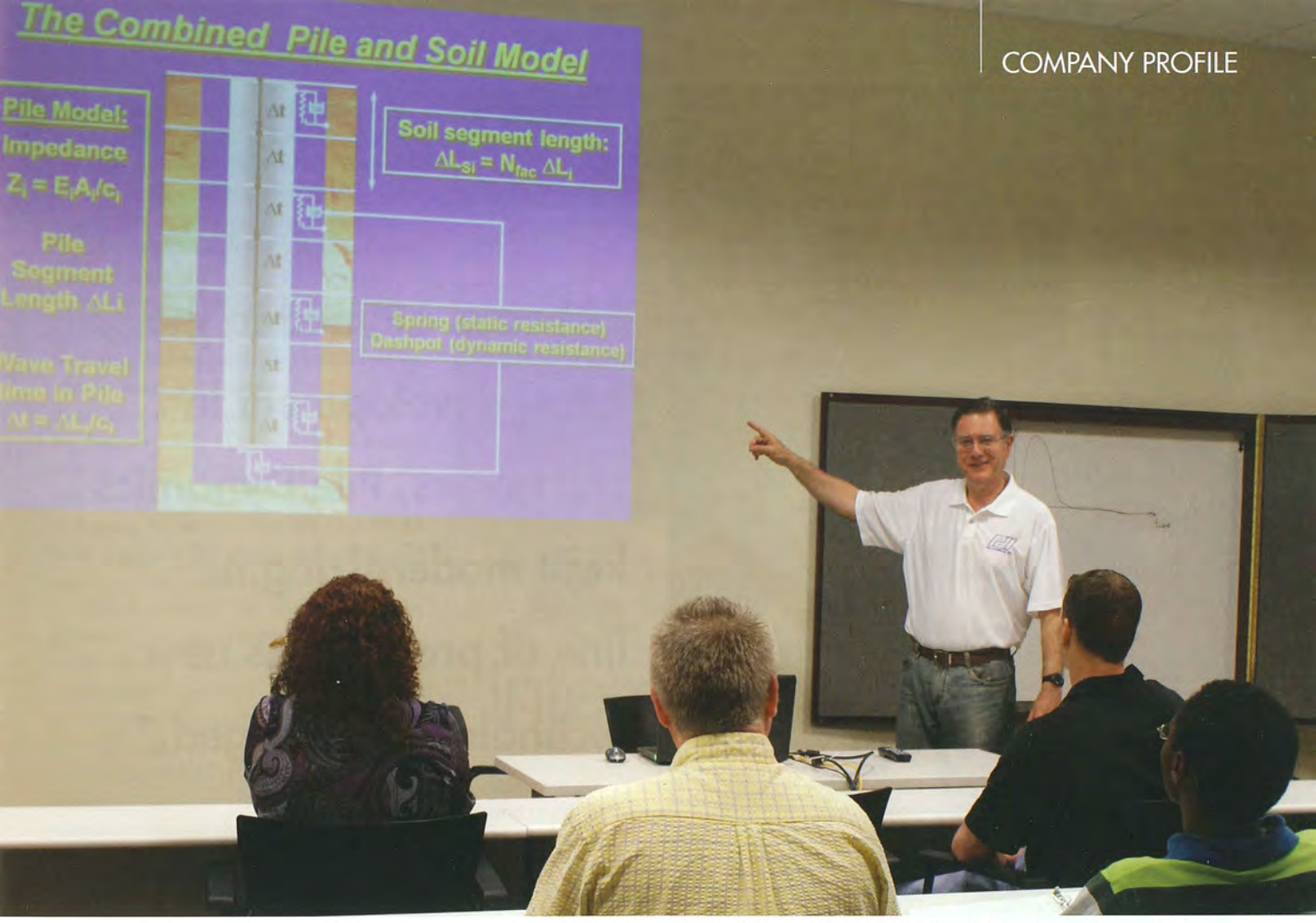


Jorge Beim, senior engineer for PDI, teaches in the training room

# Pile Dynamics – a 40-year Reflection

*By Garland Likins and Frank Rausche*

How do you take an abstract, unheard-of idea – Dynamic Pile Testing – and grow it into a method that is state-of-practice? How do you improve quality assurance procedures in the deep foundations industry? These were the challenges facing the founders of Pile Dynamics, Inc. (PDI) in 1972. With now four decades since PDI was founded, such a milestone allows reflection on the path from the early days to the present.

The design of a typical pile driving installation 40 years ago included a static soil analysis to estimate bid lengths and likely a driving criterion calculated by a dynamic formula. On larger projects, the design was confirmed by a static load test. Change has been significant, all benefitting the pile driving industry.

Frank Rausche and Garland Likins

PHOTOS COURTESY OF PDI

The Honeywell Visicorder – a historical photo from the archives

**"Always attuned to the latest development in electronics, Pile Dynamics kept modernizing its line of products as new technologies emerged."**

The industry standard procedure for driven piles now routinely includes high strain dynamic pile tests, as standardized by ASTM D4945 and mentioned in specifications, standards, norms and industry guidance documents all over the world.

The actual roots of dynamic testing date to the 1958 Master's Thesis "A Preliminary Laboratory Investigation of the Prediction of Static Pile Resistances in Sand" by Robert Eiber under the direction of Dr. Harry Nara at Case Institute of Technology ("Case", now Case Western Reserve University – CWRU) in Cleveland Ohio. Dr. Nara became Assistant Dean at Case, and in 1962 turned his research over to Drs. R. H. Scanlan and G. G. Goble, who obtained funding from the Ohio Department of Transportation (ODOT) to continue studying dynamic testing and stress wave propagation on piles.

Dr. Scanlan soon left Case for a Princeton University position, but the "Pile Project" continued through the mid 1970s, developing reusable acceleration and strain sensors and analytical methods for reliable predictions of pile capacity. Notable among the analytical methods were the "Case Method" for immediate calculation of pile capacity in the field and the signal matching software CAPWAP® that estimates resistance distribution and total bearing capacity. Both "stress wave based" methods originated from the 1970 PhD dissertation of Dr. Frank Rausche.

The earliest acceleration and strain records were collected in the field during pile driving by a Honeywell Visicorder that recorded the data by shining a light-beam on light sensitive paper spooling at 80 inches per second. Graduate students laboriously manually digitized the graphs for further study. After 1970, a portable, though heavy, instrumentation tape recorder from HP enabled recording of massive amounts of data that was automatically digitized by a Honeywell Minicomputer (8K memory of vacuum tubes). CAPWAP analysis was performed on a mainframe computer, and field data processing was done by an analog "Pile Capacity Computer". The second such instrument was used by ODOT for about two years. A later model included a printer.

Against this background, in August 1972 Dr. Goble incorporated PDI to commercialize "Pile Capacity Computers". Those had to be built in house by PDI, since established electronics manufacturers could not produce it at a reasonable cost. Following successful demonstrations of dynamic pile testing by the consulting firm founded by Dr. Goble and his graduate students Frank Rausche and Garland Likins (today GRL Engineers, Inc.), PDI received expressions of interest on its equipment from a couple of organizations. With that, PDI designed its first commercial product, and manufactured three of them. When the next generation instrument was developed in 1974, the "Pile Capacity Computer" was renamed, and the "Pile Driving Analyzer®" (PDA) was born.

After his contributions to the initial PDI efforts, in 1977 Dr. Goble left CWRU for the University of Colorado in Boulder, turning the management of PDI over to Garland Likins and Frank Rausche (Dr. Goble retired from PDI in June 2000).

Garland and Frank ran all day-to-day operations of PDI (and GRL Engineers). As the popularity of the PDA kept increasing, PDI kept growing and evolving, adding other foundation quality assurance products to its line, and attracting a host of talented, hard-working and dedicated engineers.

PDI went global in 1978, when it was approached by Swedish contractor Goteborg Betongpalar who had interest in adding stress wave measurements to their international concrete pile manufacturing business. The PDA became an integral part of their "Balken Piling System" that was exported to Asia, Australia and other European countries. This led to a worldwide exposure, ultimately resulting in PDI users now in more than 90 countries.

Always attuned to the latest development in electronics, PDI kept modernizing its line of products as new technologies emerged. The switch from an analog to a digital PDA happened in 1982, and the first PC-based system was produced in 1990. PDI pioneered portable devices with user friendly touch-screens, such as the Pile Integrity Tester (performs low strain pulse echo surface methods standardized by ASTM D5882), in the early 1990s. In 1996, it incorporated this technology into the PDA, and, in a visionary effort, added remote testing capabilities to further improve testing efficiency and reduce costs. Convenient cable-less data transmission from the transducers to the PDA was added in 2008.

Although PDI was founded specifically to develop, build and market the PDA, which remains its flagship product, over the years it has diversified its product line to include many powerful and easy to use electronic instruments for the foundation industry, as well as exceptional software. The Saximeter, developed in the late 1970s, automatically counts and records blows during pile driving, and determines the stroke for open-end diesel hammers.

Instruments developed specifically for evaluating the integrity of drilled foundations were designed, such as the Pile Integrity Tester, the Cross Hole Analyzer (performs cross hole sonic logging standardized by ASTM D6760), and the Pile Installation Recorder for augercast piles. The most recent addition to the PDI line of products is the Thermal Integrity Profiler (TIP) for drilled foundations. TIP, developed in cooperation with FGE of

PDI now has a 41,000-square-foot facility in Cleveland

PHOTO BY STONEPHOTOS / PHOTOS.COM

PDA testing in Florida in 2010

Plant City Florida, evaluates concrete quality during early curing both inside and outside the reinforcing cage.

PDI has certainly come a long way from its humble beginnings in a small rental office atop a grocery store. After expanding into a larger rental space in a Cleveland suburb in 1980, in 1985 the company moved to its own building and, after outgrowing that space, into its current 41,000-square-foot facility in July 2010.

In as much as PDI's founders were visionaries, the mission would not have been accomplished without many other talented individuals who also deserve credit for the success of this company. PDI's sophisticated instruments are designed by a dedicated staff of electronic engineers (now headed by vice-president George Piscsalko) and software engineers, and produced and serviced by highly skilled technicians.

Civil engineers complete the team, providing new-user training, continuing education seminars and prompt technical support to users. For the past 40 years, first class technical support has been a PDI priority, and this has been appreciatively recognized by its customers. Case in point, a note sent recently to PDI principal Dr. Frank Rausche by Dipl.-Ing. Jan Fischer (Technische Universität Braunschweig) reads, "... It has always been between zero and two days until I got a detailed answer from you – solving my difficulties. It's just so good to know, that someone is 'out there' to support me."

The PDI team is now 50 strong, with all dedicated to transforming state of the art research into practical, technically sound systems built to the highest standards of quality and supported through and through. These people are the heart and soul of PDI.

Certainly, the testing tools developed by PDI have improved quality assurance in today's foundations industry. Testing has indeed become "state-of-practice". Mission accomplished.