Photo Finish

Camera Technology Started Out Big and Got Small

By Sharon M. Bueno

Can you imagine a time when camera technology wasn't an option for inspecting underground pipelines?

Picture instead utility workers crawling through storm drains, checking for possible defects or leaks. Or how about just waiting for the crisis moment of a collapse or blockage before acting? It wasn't that long ago when those were the two options available to utilities and municipalities with regards to the upkeep of their water and sewer lines.

One of the first TV inspection cameras in 1957. Notice how big and bulky the equipment is. Photo courtesy of RapidView/IBAK.

We take for granted that the technology has always been available for pipe inspection, but the use of camera technology to inspect and evaluate underground pipelines is a relatively young innovation — only about 50 years. That's it. Prior to that, not much could be done to assess the condition of the water and sewer lines, which were fairly young in age at that time. In fact, nothing was typically done unless there was a problem. Proactive and preventative maintenance measures weren't even on the map.

Before camera technology, there was no way to truly know what lurked underground. Utilities had virtually no technological options and were limited in what could be done. The method of crawling through the pipes could only be used for the larger diameter pipes, for obvious reasons, and was a slow process, which could also be dangerous if the necessary safety precautions weren't followed by the workers. For smaller diameter pipes, it was even worse, as there was no method to check; the only avenue available was to wait for a pipe to block, collapse or back up onto someone's property and then dig to where the utility thought the problem was.

That all changed in 1957 when the first sewer camera was launched into the underground by IBAK Helmut Hunger GmbH Co. KG in Kiel, Germany. The first cameras in North America didn't arrive until the early 1960s and the first camera manufacturer CUES Inc. arrived in 1963.

The advent of the sewer camera cannot be overstated in importance to municipalities around the world, because for the first time, utilities had visual, aboveground access to their buried infrastructure and could assess its condition and determine how to fix any potential serious problems before they arose. Though the quality of the images being viewed early on wasn't perfect, it was better than having nothing at all. Technology had nowhere to go but up. Utilities knew that being able to see what was going on in the pipe, especially the smaller ones, was critical to the upkeep and any future expansion of their systems.

Today, camera inspection is an integral part of the trenchless network, as technology and execution have improved — pan-and-tilt, zoom lens, DVDs and digital software have all raised the bar to what can be done. The pipe inspection market is more than just the cameras themselves but also involves the data collection and storage, software and equipment accessories. The market is as big as it is competitive among the leading manufacturers.

"Prior to the mid-1980s, cities probably didn't do much inspection of their pipes. Of the hundreds of millions of miles of pipe in the United States, a lot is getting old, especially in the Northeast and along the East Coast.

Maintenance needs to be done," says Tom Schmandt, president of Pearpoint Inc.

And the sewer camera serves as the key to making that happen.

Early Cameras

Cameras have come a long way since those early creations of the late 1950s and early 1960s. Gone are the bulky, fragile and clumsy cameras that gave the user just a glimpse of what was in the sewer pipes. Today, cameras are sleek (dare I say cool looking?), compact and durable.

So what did the early ones look like? Well, they were long, wide tube cameras (some were 27 to 30 in. long and 6 in. in diameter) and couldn't travel long distances (maybe 200 ft at a time). Lighting was a huge problem, as most cameras needed high wattage lighting, which required large cabling that produced a lot of heat in the camera. They were pulled through the line by winches and if the camera happened to clunk the side of the manhole or pipe, there was an excellent chance that it would shatter. And of course the pictures themselves were in black and white, or monochrome.

"Today, the cameras are very small, the images are small and the resolution is high and the images are beautiful," says Doc Bennett, international vice president at CUES Inc., and who has been a part of the industry since its inception. "Those first cameras were huge and didn't fit into any pipe less than 2 ft in diameter."

An example of what the first camera inspection trucks looked like, circa 1958. Photo courtesy of RapidView/IBAK.

"The first cameras were winched through the line using cables and only produced black-and-white video images," says Matt Sutton, vice president of sales and marketing at RapidView LLC, U.S. business partner of IBAK Helmut Hunger GmbH. "The basic process has changed very little, but the advances in picture quality, mobility and data acquisition have dramatically increased the inspection effectiveness. Cameras are now attached to mobile tractors, which move through the pipeline under their own power and carry their own light sources."

One of the main problems with the early technology was its lack of durability. With the advent of the solid-state camera, introduced by CUES in 1984, the problem was solved. "I was [at CUES] when we came out with the first transistorized, solid-state camera," says Paul Stenzler, CUES vice president of sales. "That camera revolutionized the industry because of the durability of the imaging chip itself. It eliminated the need for the tube that was prone to shattering upon any significant impact."

Color images were introduced during the 1970s, phasing out black and white; unfortunately the camera size was huge as it used three tubes (one for green, one for red and one for blue). It wasn't until a striped vidicon was developed that a single tube camera had three filters. The late 1980s and early 1990s ushered in the era of solid-state cameras and the home video camcorder.

"A major product improvement that influenced the technology for our industry was the home video recorder," says Stenzler. "It miniaturized the optical components and created the interest by the public in the zoom lens. This product and resultant board cameras were made available to [camera] manufacturers so that they could re-package it into a sewer camera."

The 1990s was the decade that introduced the pan-and-tilt cameras, which revolutionized the industry by giving utilities a direct look at any portion of the pipe — 360-degree movement. External lighting for the camera was also a thing of the past as it was now built into the camera head. "So if your camera moved left and looked at certain area, so would the light. You would get an incredibly clear look at any portion of the pipe. You could also look directly at laterals," Stenzler says.

RS Technical developed a camera that had the light built in, using low voltage and long life light bulbs so external headlights weren't needed. "We observed that all existing mainline cameras required the use of external lightheads. This observation revealed that the lightheads created a major source of problems," says Rod Sutliff, founder and CEO of RS Technical Services. "They commonly hung up on protruding laterals, forbidding the progress of the camera, and they were a constant maintenance issue. That made us determined to build a camera with the light built in using low voltage and long-life light bulbs so no external lightheads would be required."

As technology has progressed, its impact on the camera has been huge. Camera size reduced dramatically during the 1990s, as did the size of the imaging chips during the 00s. The average camera size today is about 2 ½ in. in diameter and is 14 in. long for a mainline camera; lateral cameras are even smaller. The first completely digital camera was introduced in 2003 by IBAK.

"The data is stored in a file that allows you to inspect the pipe anytime after the inspection from any computer," Sutton explains. "The self-contained file can then be analyzed back at the office."

Storage of the pictures has changed over the years from using reel-to-reel video and handwritten reports to VHS tapes to CD-ROMS and now DVD and computer storage.

"In the early days, everything was handwritten," says Schmandt. "Then they were kept on VHS tapes. I know many, many municipalities that have storage units full of tapes. Who even has a VCR nowadays? Nothing was entered into computers until the mid-1990s. Software is a huge part of the [camera] market. I find people aren't so concerned with the video picture but are more interested in the software end of it. A lot of that has to do with preventative maintenance, tracking and recordkeeping."

Bennett concurs. "Now we have CDs, DVDs and computer storage of the data," he says. "People don't have to look through an hour of videotape to see what happened at a certain joint. Storage and getting the information has progressed tremendously as the technology has."

Market Leaders

Early players in the camera market were IBAK in Europe and CUES Inc. in the United States. Others who developed key technological advancements included RS Technical Services, Pearpoint and Aries. Today, there are many more companies involved, such as Cobra Technologies, Inuktun, Rausch and Envirosight. A market trend in recent years has been European camera companies establishing U.S. bases.

"You've seen in the last few years, a lot of the European manufacturers coming to the United States, such as IBAK, Rausch, iPEK, among others," says Schmandt. "The European manufacturers are now breaking into the U.S. market because they see how big it is and they already have such a large share of the European market. I think a lot of the U.S.-based corporations stick to just the U.S. market."

Sutliff agrees, saying, "Each manufacturer tries to outdo their competition by offering special feature gadgetry and aggressive pricing structures. The recent arrival of the European manufacturers has only made the market more complex and competitive."

The emergence of the pipe inspection market easily ties into the growth of the trenchless market as utilities use the data to determine the best action to rehab pipes. Trenchless and television go hand-in-hand.

"The camera market is invaluable to the trenchless market. The inspection camera is the premier tool for gaining knowledge of the interior condition of our pipeline system," says Sutliff. "Without the detailed video information, no intelligent underground procedures can be executed."

Camera inspections give municipal leaders and utilities the information they need to assess the condition of their pipes and determine how to address a particular defect or problem, whether it is a leaky pipe or something more significant. And they allow utilities to check the work after it's done.

"[Camera inspections] are vital to trenchless work, because you first have to do the condition assessment. Once you do that, it gives the staff the opportunity to evaluate the various methods that are now available with trenchless technology, such as grouting, point repair or relining," says Stenzler. "It has enabled the municipality to properly plan its resources as far as maintaining its infrastructure from short- and long-term perspectives."

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A look at the inside of a TV inspection truck in the early 1960s. Photo courtesy of CUES Inc.

Camera Timeline by Decade:

- 1950s: IBAK launches first sewer camera in Germany in 1957.
- 1960s: CUES Inc. develops first sewer camera in United States in 1963.
- 1970s: Color images available.
- 1980s: Solid-state cameras; zoom lens and the home camcorder/VHS storage.
- 1990s: Pan-and-tilt camera emerged, as did light built into camera head; CD-ROMs.
- 2000s: The digital age arrived; size of imaging chip reduced; DVDs and computer storage.