DEVELOPMENTS IN HEAVY CONSTRUCTION EQUIPMENT

JOHN HILDENBRAND
Manager, Crawler Sales
Terex Division, General Motors
Hudson, Ohio

HISTORY OF DEVELOPMENT

An opportunity to discuss the development of any product must include a bit of history so that having observed where we have been one may have a clearer perspective of where we are and may be going. This discussion will try to capture all of these facets.

Construction projects of one type or another date back to times before recorded history. Man's hands were undoubtedly the first tools, followed by wood and stone implements that aided in shaping or excavating earth and rock.

The invention of the wheel and the first wheelbarrow probably filled the need for the movement of construction materials. The cart followed the wheelbarrow and horses and oxen replaced the man for power but it was literally centuries before manpower, horsepower, and hand tools were supplanted by mechanical power.

Development of Tractors and Self-Loading Earth Movers

The early 1900's saw the introduction of machines that could be used on construction projects. Many of these machines were adaptations of equipment that was originally intended for agricultural use.

Holt is the man considered to be the father of the crawler type tractor (Figure 1), and his first tractors were intended for agricultural purposes. It is interesting to note that man's mind sometimes becomes so channeled that what later seems to be obvious was far from such at the moment of perception.

This very early dozer seems to be a classic example. If the rear of the tractor is used for attaching the towed implements then it should also be used for mounting the pushing attachments. No matter that the operator would develop a permanent crick in his neck from the constant requirement to turn around to watch what he was doing. If the plow belonged behind the tractor so did the bulldozer blade.

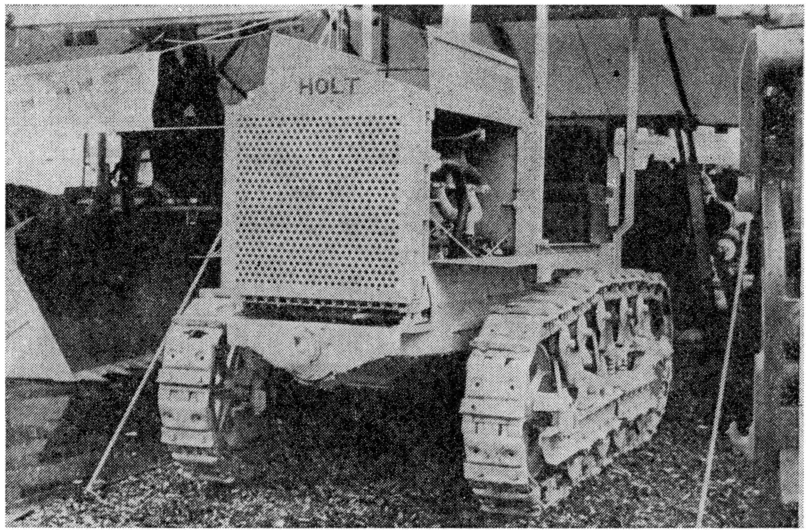

Figure 1.

Fortunately agile minds crop up in all areas and progress is made. The bulldozer was moved to the front, but if a tractor can push material it should also be able to lift it and the crawler front end loader was born. It lacks a little in aesthetics, but then so did our ancestors by present day standards.

As road projects became more complex the need to move larger volumes of material demanded more efficient machines. Certainly a

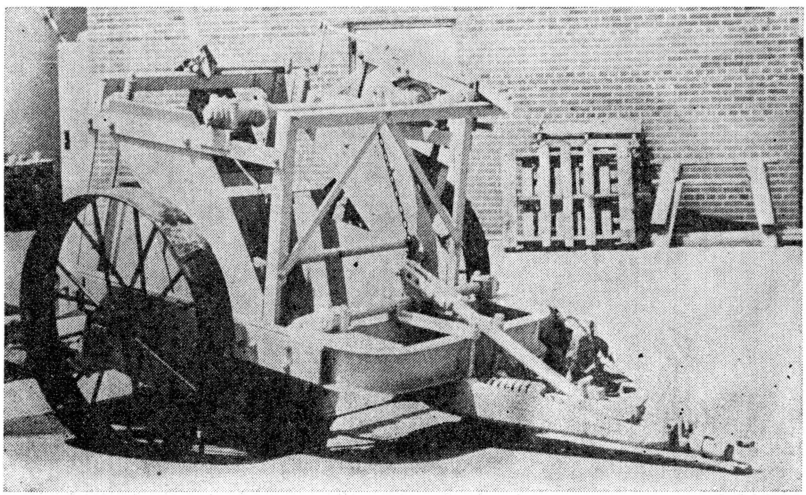

Figure 2.

cart or wagon which could load itself would be more efficient than a wagon loaded by two to four men with shovels. Necessity is the mother of invention and someone did invent a cart (Figure 2) that would load itself, and then found out that three or four of these "carts" could be pulled by one tractor (Figure 3). The first scraper had been born.

Man's continual quest for improvement made it mandatory that the tiny two-wheel self-loading cart should grow in size and ease of opera-

Figure 3.

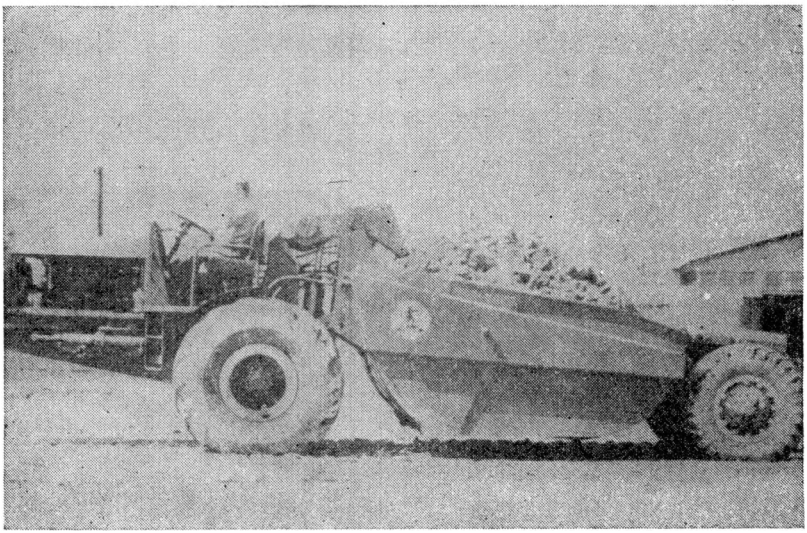

Figure 4.

tion. Cable controls on the back of the tractor made it possible for one man to move 18 to 22 yards of earth on each trip. But the crawler tractor was slow. Big, powerful rubber-tired tractors could surely move the material faster. And they could. 1939 saw one of the first of the so-called overhung tractors (Figure 4) with enough power to move 12 to 18 yards of material at a time. In addition some people believed that bowl, apron, and ejector control would be easier, faster and more efficient with hydraulic power rather than the troublesome cable which always wore and broke. The high speed rubber-tired, hydraulic scraper initially grew in favor as a three-axple unit. Despite mans ever-continuing search for change, there always remains a strong tendency to resist that change. It seemed "right" that a tractor should have four wheels instead of two.

Engine horsepower was modest by todays specifications and ranged from 150 to 300. Transmissions were stick shift and it took hours and hours of training and real skill to become a real "hot-shot" overhung scraper operator. From most operators' viewpoint the advent of the torque converter and power shift transmission was a very welcome change. Operating a scraper now was a piece of cake. The owners were just as pleased because for them it meant shorter cycle time and increased production per unit man-hour which, of course, meant lower cost per yard or ton.

Early Power Shovels and Trucks

Not all jobs have materials that can be moved with scrapers or dozers. Moving rock was a shoot, shovel and haul operation. The early hauling units (Figure 5) were only a short step beyond the horse drawn

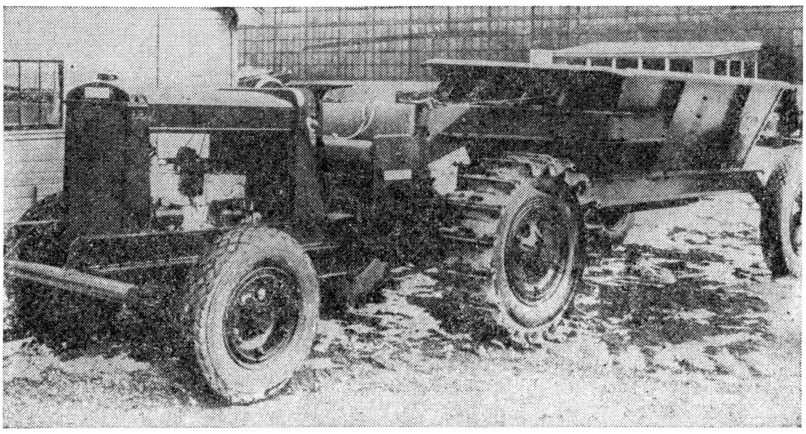

Figure 5.

wagons but they did have earlier methods for dumping or ejection (Figure 6). Loading in those days was done with steam shovels. These later gave way to diesel and electric powered shovels. Both shovels and trucks continued in growth and efficiency with the rapid advance of technology in materials and components. In retrospect it does seem like rapid advancement but in those days it is certain that the engineers felt it was painfully slow. As an example, rear dump or truck frames were basically I-beam construction. When a crack developed as a result of overstress the engineer would, in many cases, pursue it from one location to another until it, hopefull, disappeared off the rear end never to return. Unfortunately there was always the user who believed it necessary to carry one more ton and that little overstress would return and crop up somewhere else.

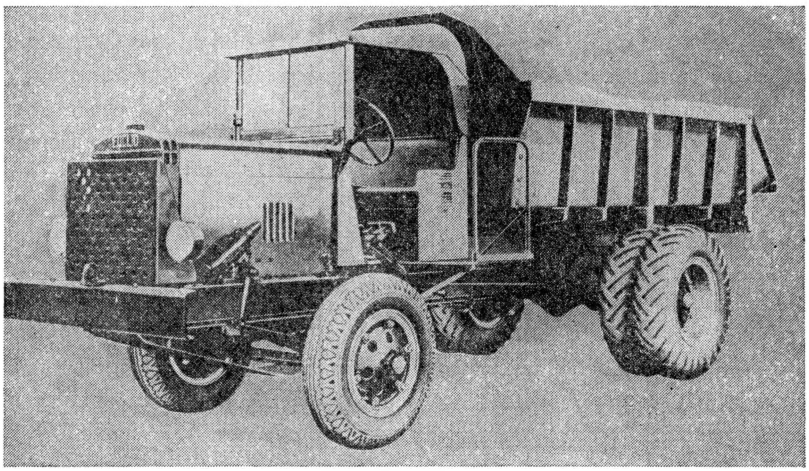

Figure 6.

The early trucks were real body builders. Power steering came early in the concept of the hauler but it was only available from Armstrong and reduced steering effort generally meant a larger steering wheel. Clutches were foot operated and required a mere 60 pounds or so of effort to operate. Transmissions were stick shift and not always with synchronizers. It wasn't uncommon for the old timer to jibe the youngsters who had missed a shift with a comment like, "Atta Boy, Charlie. Grind em to fit."

The ride also added to the operator's health one way or another. The early trucks had no springs at all. Later leaf springs, front and rear, were incorporated but it is suspected that many an operator still believed his truck had "no springs at all." Leaf springs in front finally

gave way to coil springs and the ride characteristics did begin to improve (Figure 7).

The users constant quest for lower cost demanded larger and larger units. The designers and manufacturers imagination and capability, at

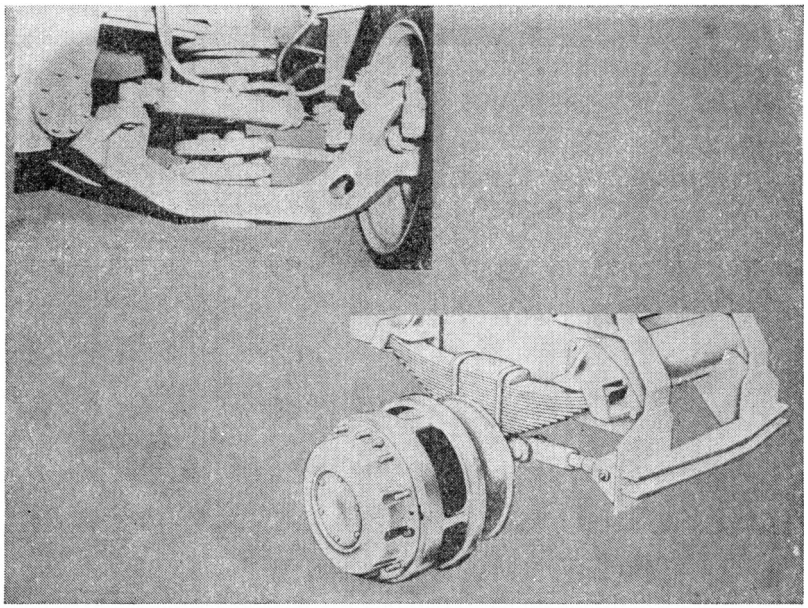

Figure 7.

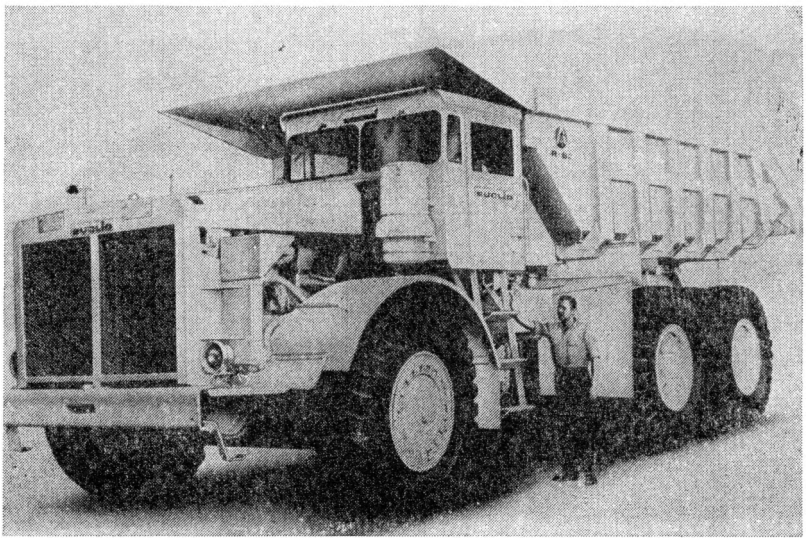

Figure 8.

this point, overran the drive-train component capacity and "twin power" was born (Figure 8). Two engines and two transmissions. Some people called it "double trouble" but others made it work and so the size and horsepower race continued.

Transmission development with the hydraulic torque converter and power shift transmissions was what really made "twin power" possible. One man simply didn't have enough hands and feet to control a manual system.

Replacing the man with the shovel has seemed to be the most difficult task to mechanize. It was not until after World War II that efforts were seriously turned toward the development of a Paul Bunyan sized

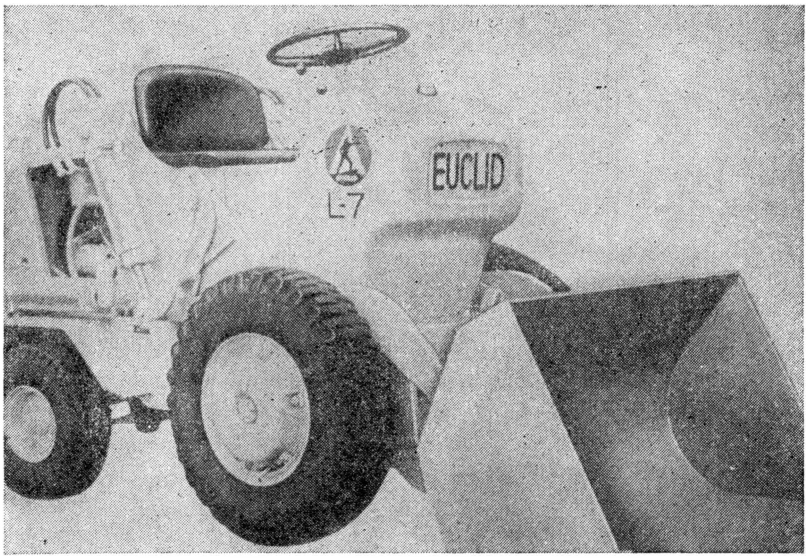

Figure 9.

shovel that could be used to quickly load over the highway trucks with the various materials of the construction trade. The early units (Figure 9) were relatively slow and unwieldy as a result of their rigid frame and rear steering wheels (Figure 10). But once again someone had a better idea. If the frame could bend in the middle (Figure 11) then the "shovel" could be maneuvered and placed with nearly the dexterity of a man with a hand shovel. "Pivot steer" and the articulated wheel loader provided that dexterity. Todays loader can be tailored to fit a myriad of assignments. Not only does the user have an enormous selection of special buckets to handle any type of material, but attachments are available for handling pulpwood, logs, all kinds of pipe—both large

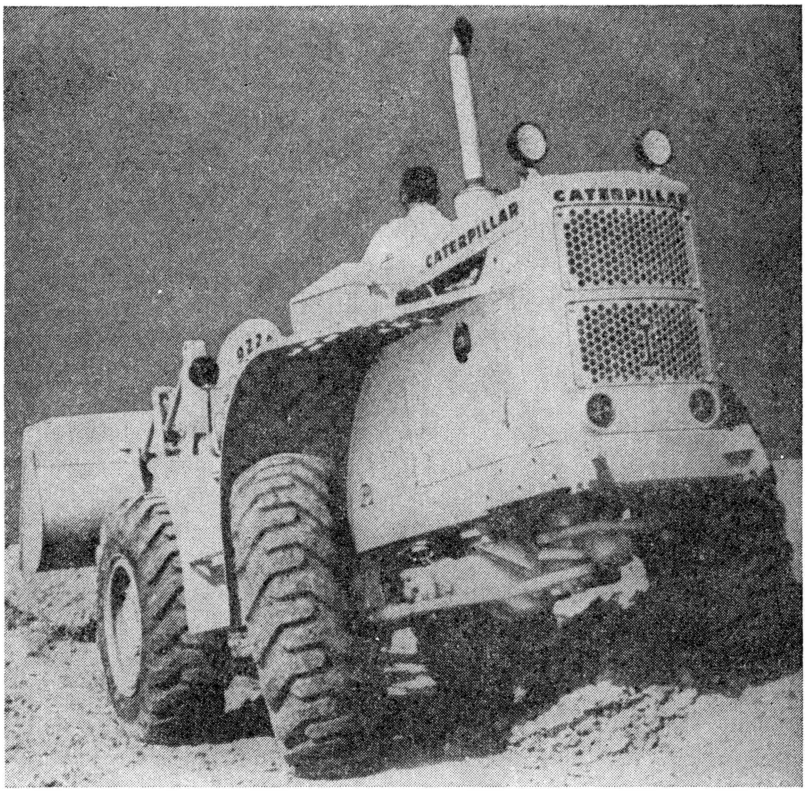

Figure 10.

Figure 11.

and small—rolls of wire, cable, and hose, plus special hitches for handling railroad cars, snow blowers, and plows. The sophisticated hydraulics for the lift and control arms have, in reality, made this machine a true extension of mans arms and hands. Its uses are limited only by the user's imagination.

The loaders primary function still remains that of a large shovel and transmissions have been developed specifically for that purpose. The torque converter has been designed so that it will "unload" when the loader crowds into a bank, thus allowing more power to flow to the hydraulic system for digging and filling the bucket.

EQUIPMENT OF TODAY

But what about today's machines and what might the future hold for us? Most of us believe that today's machines are highly complex and sophisticated. It is often amusing to hear the comment, "They don't make them like they used to," the implication being that the old machines were better. The best response, is, "Thank goodness they don't." Today's machines, all of them, are more reliable, more productive, easier to operate, and, on an adjusted basis, will produce at less cost per unit volume.

Crawler Tractors

What has happened with crawler tractors? In the 1950's and early '60's, before power train capacity caught up with demand, one manufacturer resorted to a twin-engine and transmission concept to provide the necessary push power (Figure 12) for loading large scrapers. They also introduced torque converter-driven powership transmissions for improved ease of operation. Other manufacturers followed with torque

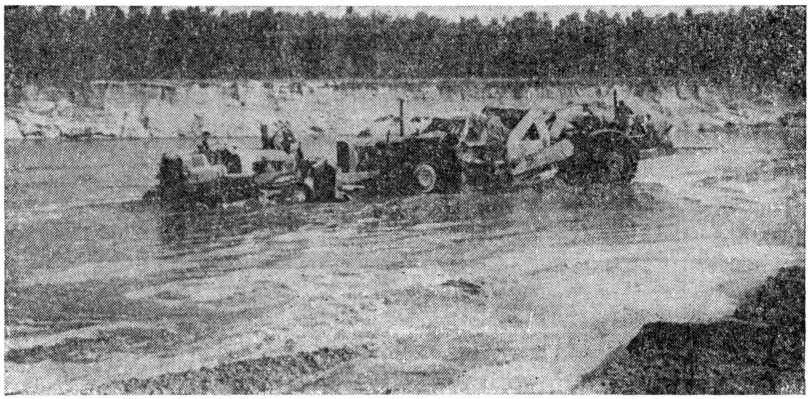

Figure 12.

converter equipped stick shift transmissions and then full power shift versons of their own (Figure 13). Steering controls were hydraulically assisted and operation became easier and less tiring. The operator's efficiency went up because he would not tire as easily during the work period.

Is the torque-converter power-shift transmission the ultimate for tractors? Hardly. Hydrostatic drive, the transmission of power through controlled hydraulic pumps and motors, is edging its way into the

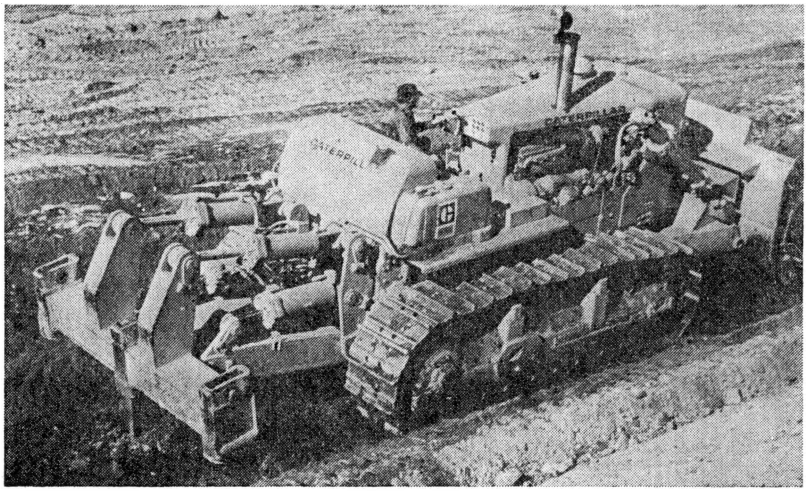

Figure 13.

picture. It features power and speed that can be adjusted to the operators capability or job requirements and increased maneuverability for improved performance in the tightest quarters.

Improved hydraulics made control of the bulldozer easier and more precise. On smaller machines not only can the blade be raised, lowered, and tilted, but it can be angled as well; all from the operator's seat. Results—increased versatility, more production, lower cost.

Is that the ultimate? Not quite. There is always a better way. Space age technology has invaded the construction equipment industry. Laser generators and receivers can now be used for fully automatic bulldozer blade control (Figure 14). By tying the laser beam receiver into servo mechanisms in the tractor's hydraulic blade system, automatic grade control can be achieved at the touch of a button. Job time can be reduced by as much as 50 percent. Base material costs can be reduced by maintaining consistent depths throughout the project.

Figure 14.

Some manufacturers have changed the suspension systems by mounting the track frames in front of the sprocket drive to eliminate shock and impact of the dozer loads. Some people thought that was a brand new idea in 1950, but some other genius thought of it also in 1935 (Figure 15).

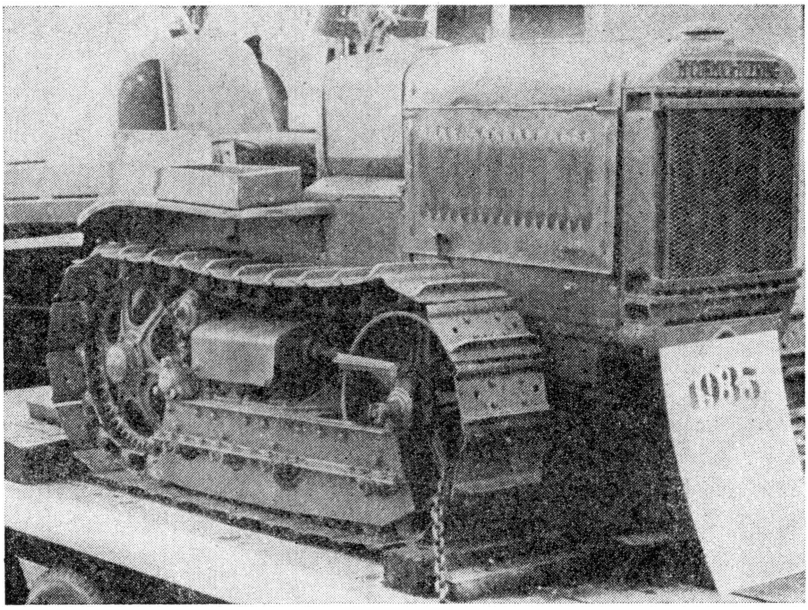

Figure 15.

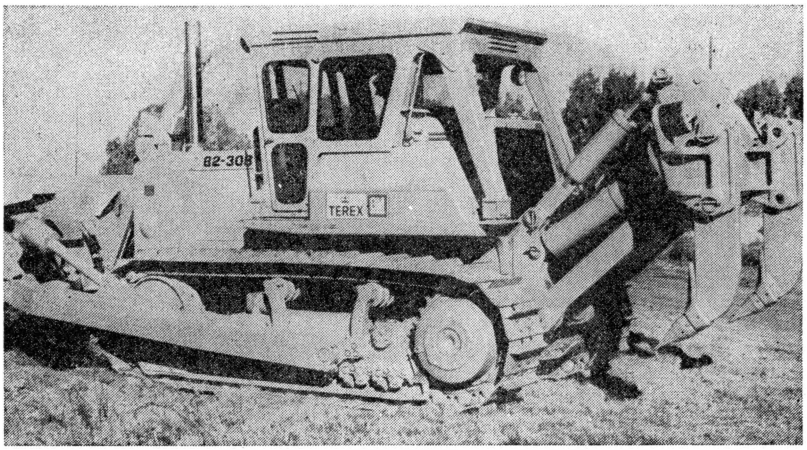

Figure 16.

Most recently, one manufacturer has made a major contribution to increased life and reduced cost of operation with the introduction of lubricated track. The elimination of internal wear in the pins and bushings has greatly extended the life of this critical component in most applications.

Most crawler tractors can carry other attachments in addition to the bulldozer. Most important is probably the ripper. It, too, has seen change and improvement. It features articulated tool beams that allow adjustment of the ripper point for the proper angle of attack to maximize production and fracture (Figure 16). Rubber shock absorbers (trade named "VYBA-Mount") reduce shock and impact to the tractor and at the same time improve fracture of the ripped material. The ripper also has a "black box" that allows the ripper control to be "programmed" so that at the touch of a lever the ripper will penetrate

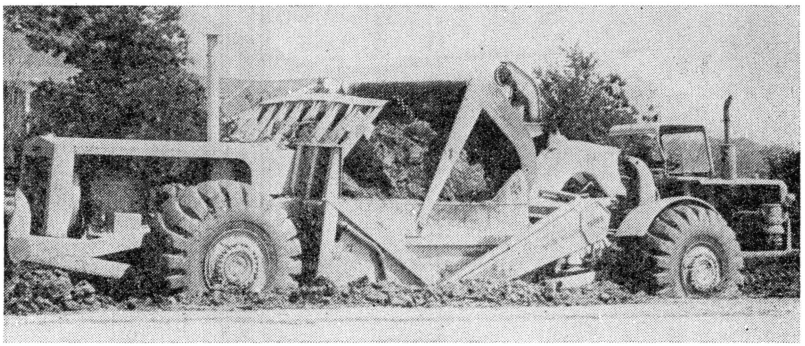

Figure 17.

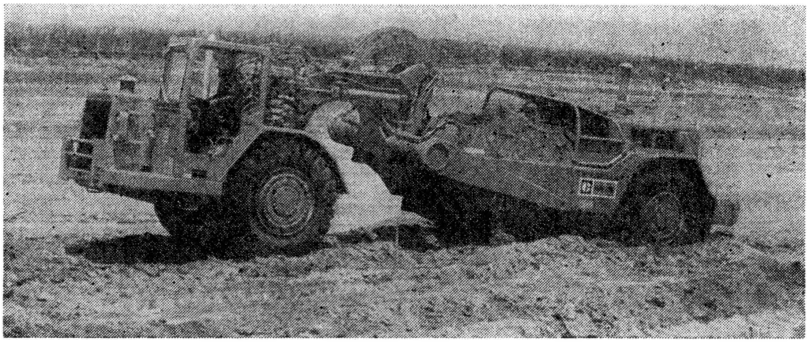

Figure 18.

the rock at the optimum angle, descend to the most productive ripping depth, and then adjust the point of optimum ripping angle.

Scrapers

Scrapers are one of the money makers. They haul the material for which the contractor is paid. The constant demand for increased productivity has brought major changes to this product during the last two decades (Figure 17). All-wheel drive has increased gradeability dramatically and allowed performance in soft and muddy conditions that could not possibly be achieved with single engine units (Figure 18).

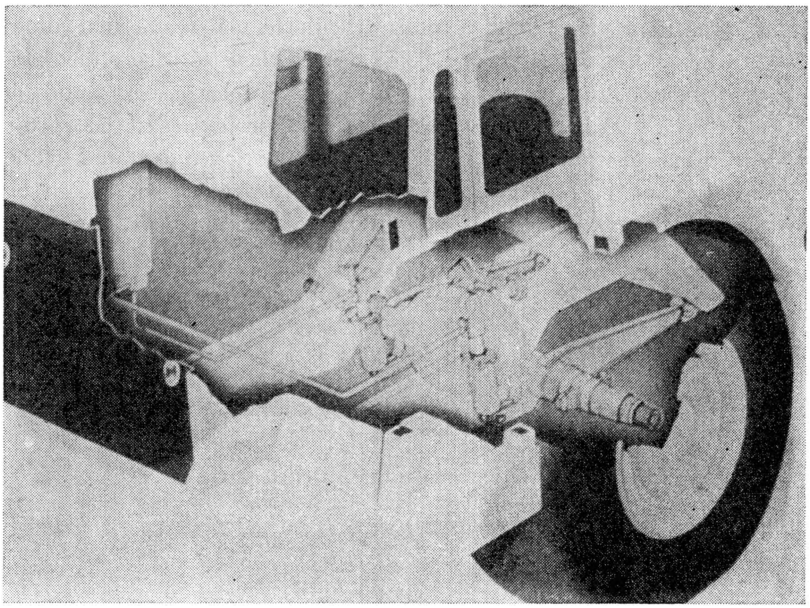

Figure 19.

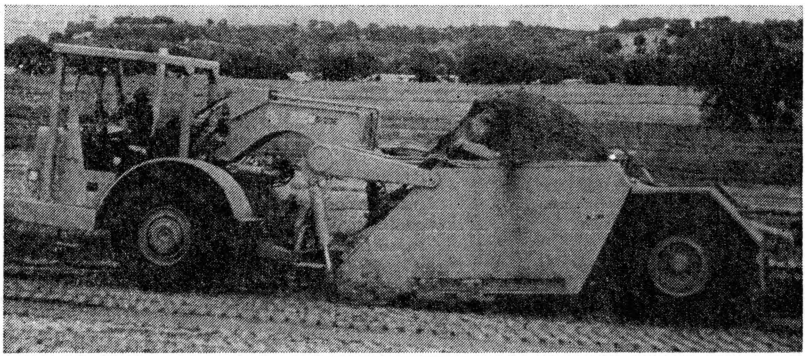

Figure 20.

Cushioned hitch and suspended axles (Figure 19) allow significant increases in haul road speeds by reducing the scrapers tendency to "lope" and also to travel poorly maintained roads at much higher speeds. Automatic transmissions maximize power efficiency and also help reduce cycle time by shifting at the most optimum times. Bowl designs have been modified for improved loading and ejection.

A new method of loading was introduced in 1952 by J. E. Hancock when he invented the self-loading elevating scraper (Figure 20). Efficiency is improved by allowing one man and one machine to load, carry, and dump material without other outside assistance. In 1967-68, a system was introduced which allowed two conventional scrapers to assist in loading each other by pushing and pulling (Figure 21). The front scraper is pushed by the rear scraper until the front one is loaded. The front scraper then pulls the rear one until it is loaded. They then disconnect and each machine travels separately to the fill. This

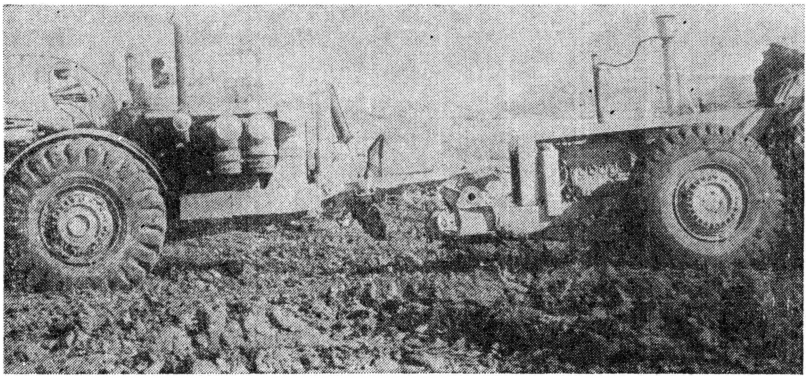

Figure 21.

system, in good material, can load both bowls in the same time that would be required to load one with a tractor pusher.

The laser control system has also been applied to both conventional and elevating scrapers. It can be installed to maintain full automatic control of the scraper cut or can be set up to perform semi-automatically through a visual light display that tells the operator to raise, lower, or maintain the height of his cutting edge.

Rear Dump Trucks

Rear dump trucks have also seen dramatic changes in some significant areas. The old I-beam main frames have been replaced by stronger

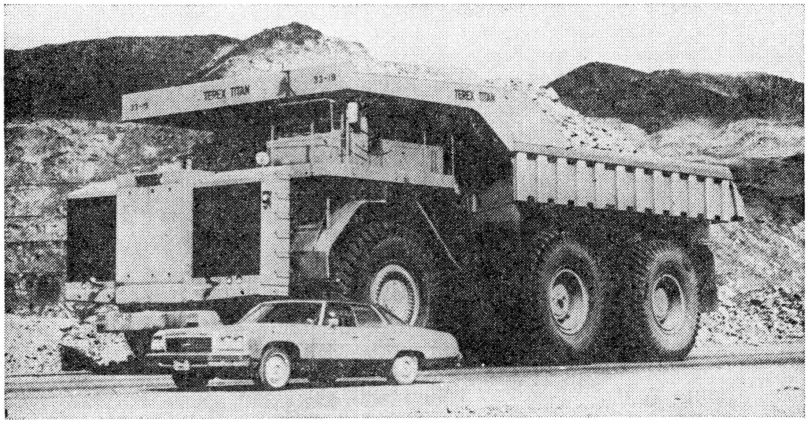

Figure 22.

more stress-free box sections. The suspension systems have probably seen the most dramatic change in going from leaf springs, to coil springs, to rubber springs and now, most common, the nitrogen over oil ride strut. This system has provided tremendous load carrying capacity with excellent shock dampening characteristics. Transmissions have changed from power shift to automatic and in the very large mining vehicles to diesel electric. Maintenance has not been neglected and in the large vehicles power modules consisting of engine and generator or a complete rear axle with traction motors, can be removed as package. The excessive size of this 350T capacity truck (Figure 22) has necessitated the incorporation of rear axle steer to allow it to maneuver within acceptable limits.

Operator Compartments

As everyone knows, the encroachment of government regulations has added noticeably to the cost of material movement; in some cases, with

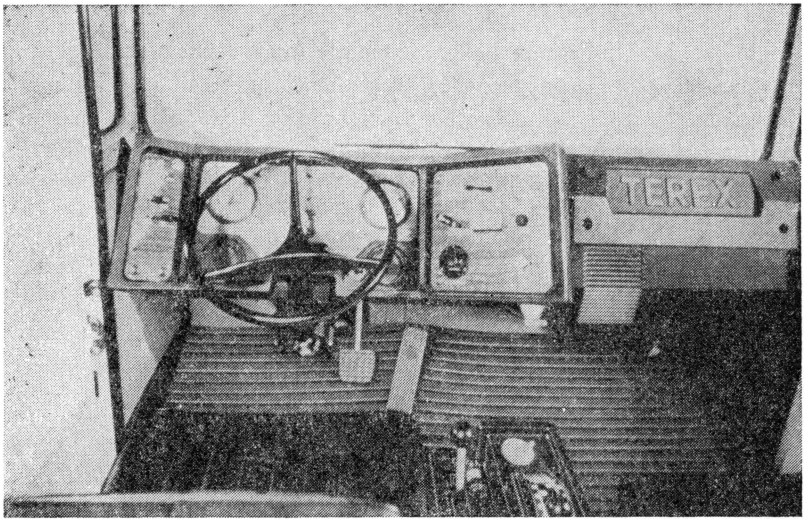

Figure 23.

no noticeable improvement in production. However, the operator's compartment is one place where regulations have had an effect that can improve production by increasing operator efficiency. Only a few years ago this operator felt reasonably comfortable, but today's cabs or compartments, whether they are on tractors, scrapers, haulers, or loaders, can provide the operator with a sound suppressed, climate controlled environment that would, in some cases, make him reluctant to leave work and go home (Figure 23).

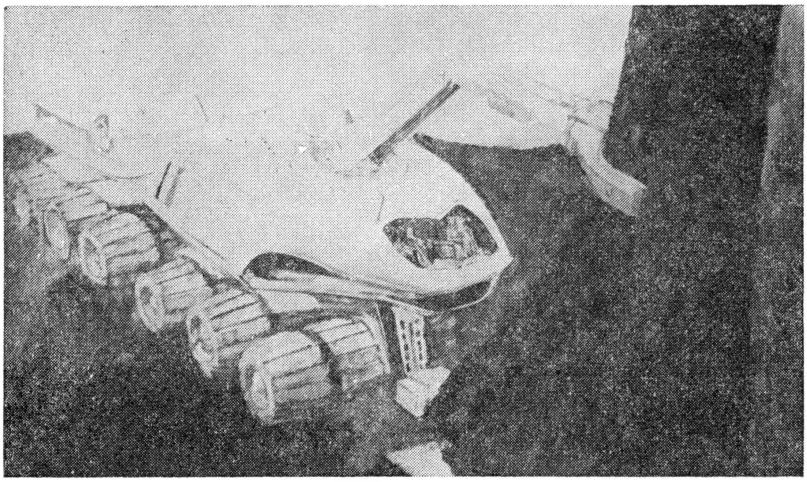

Figure 24.

FUTURE EQUIPMENT

What does the future hold? Certainly more refinement to present systems, engines, transmissions, controls—but also the addition of microprocessors, laser control and other changes toward automation that will take critical control of certain portions of the machines' cycle away from the operator in order to provide optimum efficiency to the process of moving material from one place to another.

Might this be a construction machine of the future (Figure 24)? One would be reluctant to say no. After all, look what happened to Buck Rogers.