



# Overcoming Regulatory, Productivity and Use Challenges in the Construction Market with Innovative Excavator Designs



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# Introduction

The construction market saw overall growth through 2019, despite cost pressures, labor shortages and fixed-bid projects. These challenges are anticipated to persist throughout 2020 and beyond.<sup>1</sup> As a key piece of equipment at the start of most construction projects, excavators offer an opportunity for OEMs to provide innovations that will help the market mitigate these challenges and build on trends that will improve operations and deliver competitive advantages.

Outlined in the paper are primary challenges within construction equipment as they relate to excavators as well as design engineering solutions to help OEMs, rental companies and fleet owners overcome them.



# Challenges

## Regulatory Issues

Regulations specifically as they relate to engines impact excavator operation in a variety of areas, including overall fuel efficiency, hydraulic systems, power management and noise production. Using a tiered approach to reduce emissions, the EPA limits newly produced diesel engines to near-zero levels for nitrogen oxides and particulate matter

emissions. Tier 4 is the current standard impacting diesel engines for excavators and other construction equipment. To accomplish large reductions in emissions, construction equipment manufacturers are tasked with developing technology that will produce the power and performance their customers need while adhering to the standards.<sup>2</sup>

Regulatory challenges can also extend to local ordinances that impact construction, such as noise ordinances that limit construction activities to certain times of day which can stretch out project timelines and increase downtime and labor costs.

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## Uptime and Productivity

Although excavators are powerful and generally versatile pieces of construction equipment, their traditional operating parameters create downtime, increase non-productive operation time and require optimal conditions along with additional labor beyond the operator. As the construction industry demands greater machine utilization throughout construction project timelines, productivity targets are becoming more aggressive. Traditionally, excavators are

best operated from flat ground, meaning that preparations often must be made prior to use, including using other equipment to create the necessary grade or building a berm to allow the excavator to be in the correct position to dig. Excavators frequently require repositioning to complete a job as well due to the restraints of their range of motion. Site preparation and repositioning both take significant time.<sup>3</sup>

Although only one operator needs to be inside of the cab to run the excavator itself, the excavating process for construction projects traditionally requires additional workers with shovels to complete clearing and site prep work. This can take members of construction crews away from other tasks or require more workers to be on hand earlier in the timeline than desired to do the excavation properly with the limitation of current excavators.



Site preparation and repositioning both take significant time.



## Growth in Rental Use

The global construction equipment rental market expected is to reach \$174.5 billion by 2026. Major driving factors for rental equipment growth are expected to be attributed to infrastructure improvement projects and building smarter cities as well as the trends toward automation. The market subset that continues to dominate the rental equipment grow is excavators. In 2018 the excavator segment of the equipment rental market was just over \$28 billion.<sup>4</sup> The majority of rental excavators in use are tracked “crawler” excavators, largely due to lower purchase prices compared to wheeled excavators and high stability on rough and uneven terrains. Rental equipment providers continuously invest in excavators and the average age for rental excavators is 2 or 3 years. These companies, like OEMs, are looking to satisfy customer demands with available excavators and seek to offer advanced and efficient models. An American Rental Association survey found that of the respondents who rented construction equipment in 2019, 93 percent expected to rent at least as much in 2020 and 52 percent planned to rent more.<sup>5</sup>



Spurred by new technologies and local opportunities, more regional, national and international companies have joined the rental market since 2014 when there were only a handful of large.<sup>6</sup> This increases competition for rental companies to provide customers with the best offer, relying on new technologies like IoT or brand name reputation to win rental contracts.

End users may choose to rent excavators for many reasons, including cost savings and reduced liability over owning,

or simply to fill in gaps that they may have in their own equipment so they can improve overall uptime and meet schedules.

Excavators for the rental industry may also see increased operation time over excavators that are part of a construction company’s dedicated fleet. Driving rental companies to invest in those models of excavators that provide the best lifecycle times and reliability as well as the lowest maintenance costs.

# Innovative Design Engineering Solutions

## Engine Power Management and Fuel Efficiency

To comply with emissions standards, engine power management is an extremely important design consideration. In order to ensure optimum system operation, attention to cooling is essential. Accurately controlled cooling will improve the performance of the system while reducing overall energy consumption. Parker's M5 product family is designed with hydraulic fan cooling in mind. Rugged integrated outboard bearings eliminate the need for additional bearing support while high operating pressure and efficient operation provide a highly compact and cost effective solution. Quiet operation, integrated reversing and flexible installation are all features that are incorporated into the Parker M5 fan drive solution.<sup>7</sup>

Fuel efficiency receives a boost when overall weight is reduced. Design engineers can look to balance size and weight reductions in excavators with performance requirements. Efficiency at a component level can include specifying smaller outside diameter and lighter weight hoses that can provide the same pressure and flow as traditional hoses or specifying integrated components that reduce the complexity and number of parts for systems. Integrated suppliers are often able to combine their components into packages that will work together and boost efficiency.



With the wide breadth of product Parker offers accumulators and valving can be packaged for off-road equipment. The combined solution can be used for track tensioning, power train and many other systems incorporated into excavators. Their combined solutions can be used for track tensioning, power train and many other systems incorporated into excavators. Accumulators provide energy storage, hydraulic shock absorption, auxiliary power or supplemental pump flow for hydraulic systems.<sup>8</sup> Parker's piston accumulators reduce field failure rates, helping OEMs boost construction equipment uptime and performance, while also reducing weight and, when packaged with valving, leak or failure points for better fuel efficiency and reliability.



## Operator Comfort

Designing excavators with features and technologies to improve operator comfort continues to be a priority driven by demand from equipment buyers. Ergonomics incorporated into the cabin of the excavator can both increase on-the-job efficiency and improve safety for construction crews. Cramped workspaces and exposure to vibrations have been cited as causes for injuries to construction workers, including back pain and musculoskeletal disorders.<sup>9</sup>

For excavators, improving ergonomics is often approached in the general cab design elements such as seats and handheld controls. In-cab levers and joysticks can be mounted into armrests or on control panels to help the operator maintain neutral and comfortable positions when maneuvering the excavator.



Reducing the size of the necessary components housed within the cab is also a helpful design strategy shift to improve operator comfort. Miniaturizing components and combining functions whenever possible will decrease the amount of space taken away from the operator inside of the cab. Miniaturization is a key area of innovation in hydraulic fluid conveyance not only for operator comfort, but also for weight reduction and overall machine efficiency.

Hose specifications can play a larger role in operator comfort than many designers think.

When Parker hoses are bonded and formed, they are flexible and never change shape. They are delivered in a “ready-to-use” state, typically speeding up installation times by as much as 40%. These preformed assemblies use less space, permit full-flow and kink-free performance, reduce the number of connections, potential leak points, and hose scrap, which reduces inventoried components. The clean thermoplastic core does not erode in high velocities.<sup>10</sup> Reduced-diameter hoses are also able to make a difference in the amount of space needed for hydraulic systems. Specifying hydraulic hoses like GlobalCore hoses, which are robust hoses that are specified by working pressure rather than construction. Designed, built and tested to the ISO 18752 standard, the GlobalCore system simplifies specification for OEMs and end users by providing a comprehensive family of products for the most commonly used constant working pressure classes.<sup>11</sup>



Additionally, working with a supplier like Parker who can combine components into a single system reduces both the complexity of a design, as well as the number of components to be included, thus taking up less space and allowing for better cab configuration for the operator. Component integration comes into play not only for operator comfort, but also for electrification.

## Electrification

Many OEMs are expanding their overall product portfolio with the addition of electric or electric hybrid machines. This is especially true in the arena of compact construction machines. One such machine is the “mini excavator.” While the application of these machines is in its infancy, the potential to use compact equipment in environments where noise or emissions are traditionally a concern, such as indoors, is increasing. The reduction of noise, for example, allows machines to be operated beyond traditional hours which would be previously unacceptable.

Parker’s Global Vehicle Motor (GVM) range of electric motors offers OEMs and end users the appropriate solution for all machines from compact to production machines. High power density, compact design combined with the highest efficiencies in the market provides the key. Introduction of electric solutions allow the efficiency recovery and storage of energy which would previously be wasted. Parker offers a wide range

of motors with up to over 400kW of power. With a variety of sizes, lengths and voltages up to 650V each application can be uniquely engineered to maximize your machines performance.



The design of the GVM means that it can be used as a motor or a generator. This feature facilitates efficient system energy recovery whether from smart system design or braking solutions. This can provide a means of reducing expensive battery costs, extend the range between charges reduce overall machine operation costs.

With proven performance in a wide range of applications the GVM should be considered for application whenever you are looking for improvements in system efficiency, noise free operations and compact design.

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## Improve Versatility

One solution that improves productivity for both excavators and construction crews is utilizing a tilting coupler to improve versatility. Tilting couplers have often been implemented either as an aftermarket add-on or offered as an optional feature on excavators. Introduced more than 15 years ago, tilting couplers have the power to improve productivity by anywhere from 30 to 75 percent. Parker’s PowerTilt is a unique solution that offers 180-degree side-to-side tilt and versatility, enabling surgical precision cutting for excavators on slopes and angles. PowerTilt uses an innovative sliding-spline operating technology to convert linear piston motion into powerful shaft rotation. Each actuator is composed of a housing and two moving parts – the central shaft and piston. As hydraulic pressure is applied, the piston is displaced axially, while the helical gearing on the piston OD and housing’s ring gear cause the simultaneous rotation of the piston. PowerTilt’s end caps, seals and bearings all work in tandem to keep debris and other contaminants out of the inner workings of the actuator, prolonging product life and reducing required maintenance. This enables a single machine to complete an excavating project with minimal repositioning or down time.



With this higher level of maneuverability and dexterity, PowerTilt enables excavators to be more versatile than ever before. These couplers virtually eliminate the need for additional people with shovels to assist in the excavating process. Additionally, the new angle capabilities mean that excavators can operate on steeper angles with little or no prep work to grade or build berms.

Showcasing the power of Parker’s solution, the excavating company Coast Range Construction experienced a 30 percent boost to productivity due to PowerTilt<sup>12</sup>. Coast Range used to require three machines for any given project: An excavator,



a track loader and a small dozer. By adding PowerTilt to its excavator, projects were completed one to two days faster. The small dozer was only being used an average of 90 hours a year where most machines average about 2,000 hours a year. Coast was able

to eliminate the small dozer, saving them one third of the time to complete the same work previously done with the small dozer. Reduction in equipment decreases transportation costs for the contractor in addition to the overall productivity advantage.

## Sensor Integration and IoT

Integrating sensors into systems throughout excavators provide benefits to end users, fleet owners and OEMs across the board. Sensors enable condition monitoring and alerts, increased up time and lower maintenance costs, all of which help fleet assets be managed most efficiently. Excavator OEMs and their customers have immediate access to large and robust collections of data which can be acted upon quickly to improve functional efficiencies, operator wellness and productivity.

“ *Sensor integration leads the way toward safer, cleaner, more efficient and more reliable mobile equipment overall, as well as catalyzing innovation for the next generations of connected equipment.* ”

Pressure, temperature and position sensors are just a few of the sensing technologies that should be incorporated into excavator design. The complex mechanical, electronic and hydraulic systems used by mobile equipment, when supported by digital ecosystems, are ushering in a new era of mobile solution innovation. Sensor integration leads the way toward safer, cleaner, more efficient and more reliable mobile equipment overall, as well as catalyzing innovation for the next generations of connected equipment.

For the rental market, telematics and IoT-connected equipment offer a great value. Well-established, telematics for equipment benefits both rental owners and rental users by enabling them to monitor usage and track lost or stolen equipment. Usage data may prompt a renter to return an excavator that may not



be in use for a period of time rather than pay the rental fee for it to sit idle. IoT connectivity builds onto the value of telematics as rental companies seek to integrate with the software that their customers are using on the jobsite.<sup>13</sup>

Rental companies, equipment owners and OEMs all find value in IoT for predictive and preventative maintenance as well as enabling future automation of excavators.<sup>14</sup> The performance and status data available from network connected equipment helps optimize efficient use, minimize downtime and enable OEMs to make design improvements as well as provide equipment service contracts. The Parker Mobile IoT system is a digital integrated solution connecting hardware, software and asset management specifically designed for off-road equipment, delivering real-time, end-to-end operational information.<sup>15</sup>

In its current state, IoT for excavators focuses on prognostic and diagnostic data that enables predictive and preventative maintenance to keep excavators running at peak performance and reduce or eliminate unexpected downtime. IoT also enables safer operation and regulatory compliance.

# Conclusion

As the challenges outlined above continue to impact the construction industry, innovations in equipment design, connectivity and operation will help both OEMs and contractors overcome them. When designing the next generation of excavators to meet or exceed customer expectations, select a manufacturing partner that you can trust to provide the components that enable innovations in power management, efficiency, uptime, comfort and connectivity that you need; as well as the engineering expertise to support you with integrating components intelligently and offering guidance on total systems that work together seamlessly.

## References

1. <https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/engineering-and-construction-industry-trends.html>
2. <https://www.constructconnect.com/blog/electric-dreams-will-heavy-construction-equipment-go-electric>
3. Interview with Parker subject matter experts
4. <https://www.mordorintelligence.com/industry-reports/construction-equipment-rental-market>
5. <https://www.forconstructionpros.com/rental/article/21103920/equipment-rental-industry-trends-of-2019-and-2020>
6. <https://www.constructconnect.com/blog/equipment-rental-industry-trends-predictions>
7. [https://www.parker.com/Literature/PMDE/Catalogs/Vane\\_Motors/M5/HY29-0128-UK.pdf](https://www.parker.com/Literature/PMDE/Catalogs/Vane_Motors/M5/HY29-0128-UK.pdf)
8. <https://ph.parker.com/us/21051/en/piston-style-accumulators-parker-a-series>
9. <https://www.sciencedirect.com/science/article/pii/S2093791116302554>
10. <https://promo.parker.com/promotionsite/why-thermoplastics/us/en/bonded-and-formed-hose?elqTrackId=F45265E93CC02873C40F6AB5160D3CAD&elqaid=19159&elqat=2>
11. <https://promo.parker.com/promotionsite/globalcore/us/en/new-home>
12. <http://blog.parker.com/unique-tilting-coupler-technology-gives-construction-firm-competitive-edge>
13. <https://www.forconstructionpros.com/rental/article/21103920/equipment-rental-industry-trends-of-2019-and-2020>
14. <http://solutions.parker.com/iot-systems-value>
15. <https://www.parker.com/portal/site/PARKER/menuitem.17c8315d31f057bc86a6c3544256d1ca/?vgnnextoid=b64bcaa570636610VgnVCM100000e6651dacRCRD>

