

Direct Drive Technology Trends and their Impact on Gear Drive Business

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Introduction

Gear Drives are used in many different industries – from heavy industrial (steel, mining, forestry) to light industrial (automotive, food machinery, residential elevators and wheelchairs) applications. Environmental concerns and attention to energy savings is unavoidable in today’s manufacturing business. Global warming caused by large consumption of energy is one of the biggest environmental impacts on a global scale.

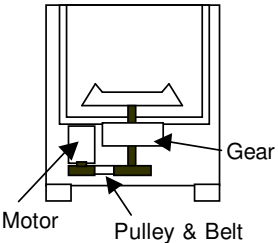
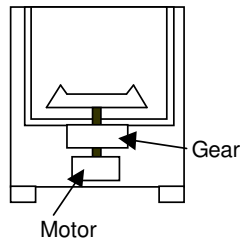
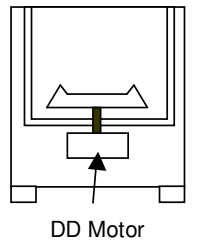
Energy savings, high efficiency and recycling are becoming increasingly important. However, with the current economical impacts that surround our environment today, businesses must weigh their options with gear drives that are typically used in most industrial applications—or opt for direct drive technology that has started to penetrate through some markets. This article will discuss direct drive technology trends and investigate their potential impact on gearmotor business.

DD Motor Trends

Induction motors are commonly used in applications ranging from home electric appliances to industrial process equipments providing advantages such as simple construction, durability, reasonable cost and ease of control. However, increasing the efficiency of induction motors has been difficult due to the large thermal losses due to current flow in the rotor. Environmental and energy concerns are driving development of higher efficiency motors due to an upwards of 70% of energy consumption in manufacturing markets. Some trends that we currently see are higher efficiency brushless DC motors being used in place of induction motors for home electric appliances such as washers, residential elevators, etc. Brushless DC motors use permanent magnets in the rotors that eliminate thermal issues due to copper losses—thus having higher efficiency.

DD motors are, by definition, motors that transmit power to the application DIRECTLY without the use of mechanical reduction elements such as gears, pulleys, chains or belts (*See Figure 1*). In order for a DD motor to replace a gearmotor, it must be able to provide high torque at low speeds, which is not what induction motors are well known for. Therefore, most DD motors that replace gearmotors have some type of Permanent Magnet (PM) motor that is paired with an electronic controller.

Figure 1: Application Examples

	Belt Drive System	Gear Drive System	Direct Drive System
Construction			
Ratio of Pulley	about 2:1	-	-
Ratio of Gear	about 7:1	about 7:1	-
Balance	Not Good	Good	Good
Low Noise	Not Good	Good	Very Good
Motor	Induction motor /Brushless DC motor	Brushless DC motor	Brushless DC motor
Torque	Small	Medium	Large
Cost	Very Good	Good	Not Good

Potential Impact on Gearmotor Business

There are several important key factors that need to be understood in why some industries are opting for the DD motor rather than the typical gearmotor. First, DD motors have high efficiency, high precision, fast response, compact, lightweight, quiet operations, low vibration, and easy to maintain. Why then, would anyone not want to switch to a DD motor?

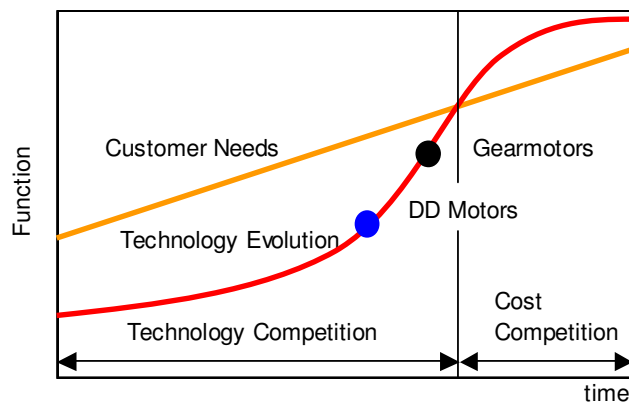
Figure 2: Gearmotor vs. Direct Drive

	Gearmotor	Direct Drive
Advantage	<ul style="list-style-type: none"> • Cost Effective • Reasonable Life • Reliable • Torque/Power • Used for Wide Range of Applications 	<ul style="list-style-type: none"> • Energy Savings ($\approx 15-20\%$) • Quiet Operations • Maintainability/Sustainability • Efficiency • Compact and lightweight • Speed, Balance and Accuracy
Disadvantage	<ul style="list-style-type: none"> • “Geared” Noise • Maintenance (Oil Changes, etc) • Vibration 	<ul style="list-style-type: none"> • Costly • Small Market • Experience (Currently only used for specialized applications)

Technology Evolution vs. Customer Needs

Technology, even in the realm of motors, develops similar to the curve shown in *Figure 3*. This figure is a time line of technology evolution and known as the S-Curve. If the S-Curve exceeds customer needs, commoditization results and followed by severe cost competition and price wars. It is said that the S-Curve of the gearmotor business does not exceed customers’ needs, but is very close to the intersection of the two lines. On the other hand, DD motors are relatively new and are still in the developing stages of the technology evolution.

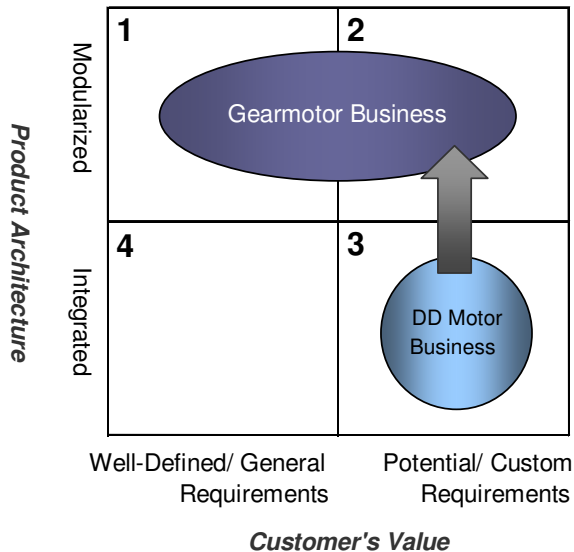
Figure 3: S-curve of Technology and Customer Needs



This can also be explained by utilizing the concept of product architecture. *Figure 4* maps the customer value in the horizontal axis and product architecture in the vertical axis. The integrated type architecture requires custom designing and can be costly. The customer value is classified into “well-define/general requirements” and “potential/custom requirements”. It is thought that gearmotors are classified in Quadrants 1 and 2. By contrast, DD motors are still custom designed and have an integrated architecture. Based on this product architecture in respect to the gearmotor market—the cost of the DD motors may shift into the Quadrant 2 in the near future. Time will most likely be required for DD motors to modularize and become standardized because

these designs are still developing and current options are still fairly flexible. There are various speed and torque characteristics, motor design architectures, and motor control schemes available.

Figure 4: Product Architecture Map



Will Gearmotors be replaced with DD Motors?

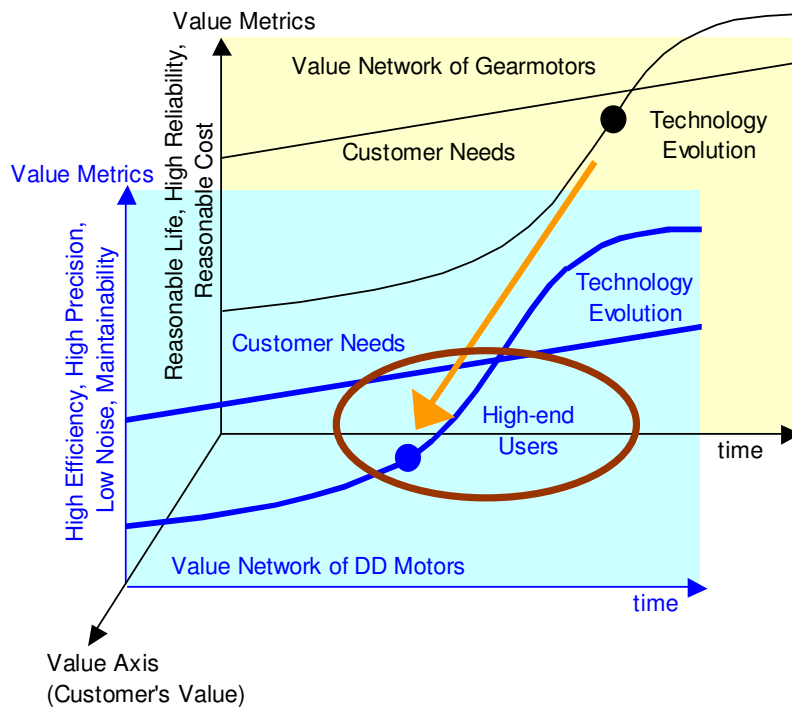
DD motors create new customer value as mentioned in *Figure 2*, and although costly, many customers have realized the benefits of switching over to this new technology. If a customer's value is mapped within the concept of the "Value Network" (*Figure 5*) that shows time in the horizontal axis, the function (value metrics) in the vertical axis, and the value network in the axis perpendicular to the page (z-axis)—the value networks of both products can be shown in relation to one another on different plains. The different customer needs are dotted 3-dimensionally around the customer needs line. Likewise, the different variations of the products are distributed 3-dimensionally around the product technology evolution line. As time progresses, the customer needs line and the product technology line begin to approach one another or separate from one another. Currently, the value metrics we can identify for the gearmotor network are (1) reasonable life, (2) high reliability and (3) reasonable cost. On the other hand, value metrics identified for DD motor network are (1) high efficiency, (2) high precision, (3) Quiet Operation and (4) Maintainability.

As previously mentioned, the DD motor technology is still in the developmental stages of the technology evolution and is yet to be modularized. Therefore, it can be said that DD motors are only used for specialized applications for high-end users and the size of the DD motor market is still relatively small. The gearmotor market as a whole incorporates a wide range of applications—some of which are well outside the realm of the DD motor market. If we restrict the study of the gearmotor market to only that involving speed control, gearmotors still provide a more practical advantage. Gearmotors are still a moving target and can still be paired with PM motors to improve efficiency and new lubrication technologies are continuing to improve gearbox efficiencies.

DD motor applications that can accept tradeoffs between high efficiency and high performance vs. high cost and integrated packages are still not a commonplace. However, new values such as energy savings, sustainability costs, improved performance due to growing attention to

environmental concerns such as increasing CO₂ emissions may nudge macroeconomic factors to replace gearmotors at a higher rate. Other factors that will impact the market towards the shift in DD motors could include new technologies that include design and manufacturing techniques yet to be unveiled. Furthermore, governmental regulations and development of new industry standards may tip the shift towards more DD motor applications. Nonetheless, we should continue to watch macro trends for DD motors in the future.

Figure 5: The Value Network (Gearmotors vs. DD Motors)



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