A Consideration of Automotive Fasteners

by Peter Standring

I once heard a motor vehicle described as, "A medieval suit of armour on wheels." On reflection, that is a rather interesting analogy given that both articles protect the person inside but in very different ways. The armour is designed to be flexible to allow movement yet stiff enough to prevent penetration by hard, sharp items. By contrast, a motor vehicle is basically a rigid compartment. In essence, both structures are shells fabricated from multiple stiff parts which are held together by fasteners. The functionality of the whole is determined by how each fastener interacts with the parts it is in contact with and as part of the designed system.

On a motor vehicle there are significantly larger numbers of individual fasteners than there are parts which require fastening. An estimate of between 6,000 and 10,000 fasteners per vehicle would not be far wrong. Of course it would depend on the vehicle construction be that: chassis, monocoque or space frame.

Depending on the vehicle type, the rigidity of the 'body in white' will be obtained by resistance welding (spot and/or seam), brazing (of the roof), adhesive bonding plus self-piercing rivets for spaceframe designs. Additionally, the fixture of brackets, supports, nuts, screws will be attached for future use in the vehicle assembly. As the vehicle progresses along the line every item which is assembled requires some kind of fixing device. Moreover, every pre-assembled unit provided by suppliers and sometimes installed by them on the vehicle will in itself, have one or many fasteners to produce the integral unit.

In some cases the simple crimping of an item will be the fastening element or it could be a multi-piece fastener with nut, screw and associated washers, locking devices, etc.

Fig 1 shows the growth trends of the automotive industry to its present number of around 100 million per year. This means that in 2020 it will require 600 billion to one trillion fasteners just to stand still. And that doesn't include the aftermarket!

Years	Vehicles Produced (m)	Growth rate/year	Trend
1960 – 75	15 – 45	2	Post WWII prosperity
75 – 80	45 – 38	-1.4	Oil crisis
80 – 00	38 – 58	1	Redirection of global investment funds from industrial societies to oil producers
00 – 15	58 – 91	2.2	China growth
15 – 18	91 – 95	1.3	Economic slowdown

Fig 1. Growth rates and trends of global automotive production 1960 – 2018

OK, that is the here and now but as always, it is tomorrow which matters most. Analysts make it their business to collect and use data to predict the future. Given the alternative of a crystal ball, data compilation is a tried and well accepted method of guessing. However, factors which cause deviations from the trend path are the real issues which few spot until they have happened. As such, these unexpected moves often produce the biggest upset. This Author, has no claim to see further into the future than anyone else but in this article would like to offer a view of the automotive world which is beyond the limited horizon of vehicle production and registration figures.

Automotive Production Trends – Cause and Effects

The timeline shown in **Fig 2** presents a sequence of some activities which have influenced the direction in which the global automotive industry has travelled in the last 100 years.

100 years ago, through its introduction of: assembly lines, globalisation, pay and conditions, the Ford Motor Company has provided a route map for the industry's development. Without doubt, the clear leader in the mid 1960's through the 70's was the Japanese automotive industry by its strategic design, manufacture and marketing. The tsunami which swept away most non-Japanese global manufacturers of motorcycles was rapidly followed by their cars. These were readily available to purchase offering, as 'standard', items which in many domestically made vehicles were sold as 'optional' extras.

Date	Cause	Effect
1911	Ford opened first plant outside North America in Manchester, UK. By 1925, Ford had plants in: Europe, South Africa, South America, Asia and Australia	Globalisation
1913	Ford introduces world's first automotive assembly line	Mass production
1920	Ford produces 1 million vehicles in one year	Mass production
1920 1940	USA has 200 manufactures of automotives USA has 17 manufacturers of automotives	Rationalisation
1960 – 75	Production grows to 30 m vehicles/year	Mass production
1973 1981	Oil crisis. Price rises from $3 to $12 a barrel Oil crisis. Price rises to $32 a barrel	Fuel efficiency
1970's	Fuel economy, smaller vehicles, imports, tariffs, transplants	Fuel efficiency Globalisation
1980's	Safer vehicle design/construction Automation	Increases in vehicle weight Mass production
1990's	Weight saving	Fuel efficiency
	Electronic data transfer (Portal development/preferred suppliers) Cost cutting (of suppliers – Lopez factor) Rationalisation of suppliers (increase volume output – scale of economies) Platform sharing Vehicle architecture (modular construction) Flexible manufacture	Rationalisation
2000's	China joins World Trade Organisation (WTO) China offers market share in exchange for technology transfer Build to order Alternative power sources	Globalisation Mass production Customisation Technology and market readjustment
2020?	Trade wars Population growth – most people living in Asia Climate change Over 70% of global auto production in Asia Rationalisation of OEM's Large plants vs. small regional plants Further standardisation of vehicle parts Higher volumes of production – fewer producers Increased demand for public transport – primarily for city dwellers Individual freedom of automotive use restricted	

Fig 2. Automotive Manufacturing Trends (1911 – 2020 and beyond)

The inevitable ‘trade war’ which followed in both the USA and Europe led directly to the emergence of the Japanese ‘transplant’ assembly plant. This brought in the concept of ‘local content’ being required to supply the transplants which in turn introduced the Japanese satellite supplier transplant to serve the OEM. These new supply chains raised local manufacture to the standards demanded by Japanese transplants for their employees and outsourced local suppliers. The overall effect was to raise manufacturing quality and capability through the adoption and achievement of International Quality Standards of Accreditation.

The 1980’s saw billions of dollars expended by the big three US automotive companies as they sought to automate almost everything in an attempt to beat their Japanese competitors at their own game. Consultants had convinced senior management that the secret of Japanese success in achieving quality and reliability was through investment in automation. Unfortunately, without standardisation of control units, many of the complex automated systems located within US plants were unable to communicate. What was not appreciated at the time was that Japanese success in manufacture was based on making things simple and error free.

Automated manufacture came at a cost but it did assist in improving both throughput and quality. Hence, to justify the increased costs, all OEMs sought ways of creating demand through increased product and part sharing across models. Additionally, the concept of cost cutting was launched by General Motors with the 1990’s Lopez driven price down squeeze across its supply chain.

The 1990's also saw a slew of OEM mergers and acquisitions as OEM's sought to gain market share. This led directly to more models being gained which was added to by increasing the number of vehicle segments, for example, SUV's, super minis, hot hatches, etc. OEMs sought to rationalise these options by use of shared componentry. Also, with the adoption of electronic data exchange (operated through OEM Portals) the concept of 'preferred suppliers' was introduced the objective being; 'the fewer the better'.

A major problem which OEM's faced with low volume model choice, was the inability to assemble them on an existing line. So, the lower numbers of a cabriolet or station wagon version of a popular brand were often assembled in the plant of a Tier Half supplier. This need has been virtually eliminated by the development and adoption of 'flexible' assembly lines where a number of different vehicle types and models can be built on the same line. In design, Platform Sharing was also adopted followed by standardisation of vehicle architecture whereby individual components were further rationalised into unit modules and sub assemblies.

At the turn of the 21st Century the elephant in the automotive room was China and it's 2001 acceptance into the World Trade Organisation (WTO). Having over 150 individual automotive manufacturing companies producing less than 2% of the global vehicles, the Government offered non-Chinese motor manufacturers a 50% maximum share of its potential market by linking with a domestic joint venture partner. In return the Chinese Government demanded only state-of-the art vehicles be built in China and full sharing of all imported technology/training.

After only 20 years, China is now established as the largest automotive producer in the world with a projected home market four times the size of the current world output.

In the 21st Century, global manufacturers outside China were busy developing their ideas on 'customisation.' Having established, Just in Time (JIT) assembly line delivery, flexible model assembly and controlled supply lines through use of their electronic Portals, OEM's naturally sought to close the customer loop by offering, 'build to order' vehicles. The deal; select any: vehicle type, model, colour, engine, gearbox etc., and a unique, self-designed vehicle can be yours! The benefits for the OEM being, organised production and the sale of multiple options. The reality; that customer choice for a 'built to order' E class Mercedes could result in providing 1.3 trillion options!

And Tomorrow?

In the fall of 2019, at least within the UK, all vehicle showrooms, through the top to budget range, appear to be full of new cars. Given the policy and technical capability of 'build to order', this should not be happening? A simple reason could be that the 'build to order' system does not attract sufficient customers to supply the 70% throughput needed to allow the assembly plants to meet their breakeven targets?

Efficient mass production will only generate income when operating with sufficient throughput to justify the costs incurred in setting up the plant. This is normally around 70% and anything less will fail to make the down payments. If and when this happens, the OEM marketing departments are called in to propose vehicle orders which can then be foisted on reluctant brand dealerships.

No matter how desirable the product, without a customer it is only a debt. The emergence of lease hire vehicles has been an attempt which OEMs have used to smooth out the perturbations of actual 'build to order' throughput. However, the easy to simulate efficiencies which are obtained when imputing JIT data into computer models, only work in reality when someone, somewhere down the line, holds sufficient buffer stock to help mitigate the actualities of demand. Given that every aspect of a motor vehicle relies entirely on the fasteners which hold it together, OEM's and their supply chains should always treat those who supply them with the respect due to their unique position.

Number of Fasteners in a Motor Vehicle?

The answer to this question can only be a crude estimate given the range of vehicles produced and the different models within them. **Fig 3** attempts a 'gross' assessment of fastener use for a standard passenger car of monocoque construction. A figure of six to ten thousand fasteners per vehicle is a range which is quoted and since around five thousand would be welds on the Body in White, even ten thousand fasteners per vehicle could be a conservative estimate. Clearly, in the coming years the transition from IC engined vehicles through hybrids to full electric will alter the number of fasteners used – hybrids increasing, full electric decreasing?

UNIT	No. of FASTENERS (est)
Body in White	5000
Engine (IC)	1000
Gearbox	500
Suspension/Steering	500
Seats	500
Electronics	500
Instruments	300
Upholstery	500
Security	500

Fig 3. Estimate of number of fasteners used in a monocoque constructed passenger vehicle

Estimating the cost of fasteners is also complex. For example, reducing the number of welds would save time and cost. However, this saving would need to be offset against the direct costs of the equipment by increasing throughput otherwise payback time would be increased. Also, it would be difficult to determine the number of fasteners incorporated into outsourced individual modular units such as: bearings, electric motors, instrument clusters, sensors, security systems, etc.

However, **Fig 3** does allow those producing fasteners for use in various parts of a vehicle to assess further opportunities or potential threats to their business.

Rolling forward, **Fig 2** indicates a number of issues and events which lie over the 2020 horizon. Clearly, human aspiration and growth indicate a constant upward trend for the benefits of prosperity. However, the roller coaster of history has often produced negative trends as shown in Fig 1. This was the case for the automotive industry between 1975 and 80 due to the increases in the price of oil and the consequence of investment funds shifting from the industrialised countries to oil producers.

The growth years from 2000 to 2015 were entirely due to the emergence of China as the largest automotive producer and market. The cooling between 2015 and 2018 could indicate a trend which may continue until some of the issues indicated in **Fig 2** are satisfactorily resolved. To this end, I offer a simple slogan for use by any politician who might want to adopt it. "Please fix our future - so the fastener industry can continue to fix yours."