Fastening: A Future

Opportunities for Automotive Fasteners to Change the World

by Peter Standring

Introduction

In his recent book 'Seven Lessons on Physics' Rovelli states, 'We belong to a short lived genus of species. All our cousins are already extinct. What's more, we do damage.'

Since there are over 7 billion humans living today with a forecast of the global population peaking at ~9.5 billion, it might be, since we are so successful, Rovelli's view is hopelessly wrong? That is until we consider the scale of resources required to sustain 9.5 billion people.

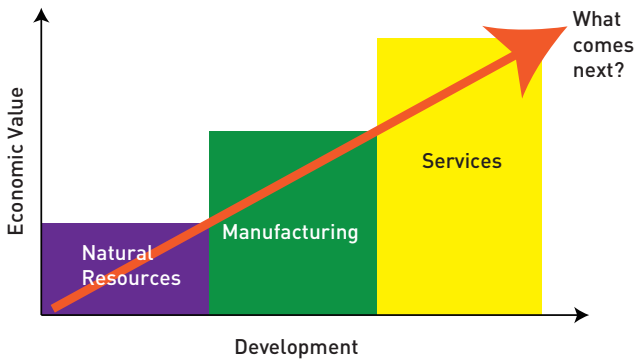

Figure 1. Economic Development of Nations

The simple chart shown in Figure 1 is the author's concept of every nation's economic development. Initially, there are natural resources which, if the population can't protect or use them, will be obtained by those who are able to manufacture.

The ability to manufacture products on an industrial scale, has been and remains the route to raising national livings standards. With this skill, follows the need to gather, safeguard and use the wealth which manufacturing can provide. This third stage in a nation's economic development is obtained by the availability and growth of its service sector, particularly that which deals with financial matters.

The major question which the author has posed on many occasions and has never yet received a sensible answer is: 'what comes next in a nation's economic development when, like all so called first world countries, the financial services sector has been established and the manufacturing base on which the initial economic success was built has been ceded to other emerging industrial nations?' The focus on high value manufacturing is simply a short term transient phase which evaporates if the industrial infrastructure to sustain it is lost and when the developing nations emerge which can do it better.

Automotive Industry

In the first year of this century, China produced ~2 million vehicles. However, opening its market to foreign vehicle manufacturers on a 50:50 basis through technology sharing joint ventures with domestic Chinese partners has seen that number explode in 2016 to ~26 million.

It is well known that the jewel in the crown of all automotive OEM's is the electronic systems which they have developed for both technical and commercial purposes. These create the design to legacy data on which all manufacturing operations depend and provide the portal through which all tier one suppliers must operate. With the rush of foreign auto OEMs into the Chinese market along with their supply chain partners, the question which this raised in the author's mind was, 'Which electronic networks would the joint venture companies formed in China choose to operate with?'

Surprisingly, although the author sought answers to this simple question from many automotive OEM's and at the highest levels, no response was forthcoming. It took almost a decade of study before the answer was provided and published in a PhD thesis produced by Mei Yi Winnie Song at The University of Nottingham, UK entitled, 'The development and use of electronic business in the Chinese automotive supply chains.' The default position it appears, was for the joint venture companies to use the existing electronic networks of the foreign partner.

What emerged from this work, was the inevitable conclusion that initially, where something didn't exist within China, then it would be adopted until, perhaps, a Chinese version could offer an alternative. It was also revealed, that the purchasing power of the Chinese Government was of the order of 1 million vehicles a year. Clearly, with a demand of this size, it would be a very simple matter for the Government to 'encourage' vehicle manufacturers to produce the type of vehicles it promoted in its policies, e.g. electric, hybrid etc.

Given that the growth of vehicle manufacture in China has been primarily for the domestic market, the question all OEMs have on their minds is, 'how big could this market actually become?'

Figure 2 shows the well known distribution of vehicle ownership across developed and BRIC

countries addressed in terms of numbers of vehicles per thousand head of population. This clearly shows vehicle ownership in the USA at ~800 per 1000 people, whereas in China, it is ~100 having been in single figures a decade earlier. It has been suggested that by 2030, China will have a vehicle parc of 1 billion and a domestic demand of over 200 million cars per year(1). Last year, the global output of all types of vehicles was ~85 million.

If the Chinese population obtained over 200 million vehicles a year (and this is only 25% of the USA number) then India the same, plus the rest of the 9.5 billion people who could afford them, the resources of the earth would be totally overwhelmed. Perhaps this was what Rovelli meant in his dark statement that he did not believe the human species would last.

Where to from Here?

Assuming an average of 10k components in each vehicle build, then last year there will have been 850 billion automotive parts produced, shipped and fitted. This figure does not include the aftermarket which assuming an average vehicle life to be ten years, could double the figure.

Of course, human demographics are constantly changing to meet the demands of 'quality of life.' Therefore the modes of transport in 2050 are likely to be quite different to those of today. One clear trend seen now is the popularity of vehicle leasing for both commercial and private use. This obviously means that ownership of the vehicle remains with the OEM/Finance company. At the end of the three or four year leasing period, the vehicle is returned and then sold at auction.

A scheme proposed a decade ago by the Author and since refined would have the new vehicle returned by law after three years of use to the OEM and they, with their supply chain partners, would 'remanufacture' the vehicle and sell it as a 'B' vehicle, the original version being an 'A'. Again, after three years use, the vehicle would be returned to the OEM for 'remanufacture' and sold as a 'C' with full warranty etc. After nine years of total use the vehicle would be returned to the OEM for scrappage (2).

Such a scheme, shown in Figure 3, would triple the number of vehicles an OEM makes and sells each year. The 'remanufacturing' every three years would also allow the inclusion of any improved safety systems, traffic control sensors and general updates as demanded by the regional authorities.

At the end of vehicle life, it has been shown that many of the metal components could be sold on for use in other applications, at a lower cost to the purchase of new primary materials. The high volume nature of the automotive industry would ensure full material and processing accreditation for those buying the scrapped components and their reuse would make significant savings in both energy and CO2. (2)

Since the automotive OEMs always obtain their raw materials at the 'best' price, and also have the lowest manufacturing costs, selling the end of life parts ten years after they were originally bought and paid for would make it possible for OEMs to recover the full cost of their original material purchase. In essence, paying nothing for the parts they recycle! (2)

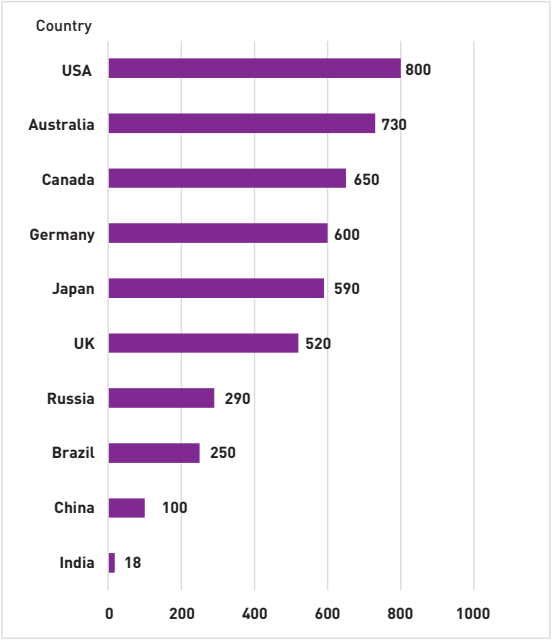

Figure 2. Number of Vehicles Per 1000 Head of Population

	New Vehicle Class (10^6)			Existing Cars (10^6)		Total Cars (10^6)
Year	1	2	3			
1	15	0	0	15	15	45
2	15	0	0	15	15	45
3	15	0	0	15	15	45
4	15	15	0	0	15	45
5	15	15	0	0	15	45
6	15	15	0	0	15	45
7	15	15	15	0	0	45
8	15	15	15	0	0	45
9	15	15	15	0	0	45
10	15	15	15	15 → Scrap		45
11	15	15	15	15		45

Figure 3. Introduction of Three Year Car Programme. Assumption ~15 Million Class A Passenger Vehicles Produced/Year

How to Make It Happen

Government legislation is a 'must' if a three year car is to become a practical reality. The increasingly popular leasing system, could be a developing trend which may make a Fixed Life Car attractive to OEMs? In 2009, the proposal was put to Guenter Verheugen, then EU Commissioner for Industry, who in turn passed it through to his technical department for consideration. As yet nothing has surfaced. Of course, any Government could adopt such a policy. If they did, it would require those importing luxury vehicles to remove or scrap them if they didn't have a 'remanufacturing' plant in the country. As President Trump might say, 'create more jobs to support your business in our country or pay for the privilege'.

From a manufacturing point of view, the most important factor in establishing a three year car programme, would be the need for OEMs to introduce design for disassembly into their vehicle programmes.

It is envisaged that a vehicle 'remanufacturing line' would operate in a similar manner to a normal assembly line. As illustrated in Figure 4, strip down would remove, clean, inspect and establish the vehicle as being sound and ready for part reassembly. OEM supply chain partners would be responsible for disassembly of their parts and reassembly at the appropriate place on the rebuild line.

Fastening is the Key

Many years ago when vehicles were embellished by having chromed 'go faster' strips attached along their sides, it was found that exposure to the ammonia used in the car washes of the time could cause the fittings to degrade thus releasing the strip to act as a 'spear' flapping alongside the bodywork. The author recalls an off hand remark made by engineers from Ford R&D when they were addressing this problem. They stated that from a recycling point of view, all vehicle manufacturers would dearly love to have a method of putting a vehicle together, which like the circus clown's car, could be instantly caused to fall apart.

Specialist disassembly methods do exist, ejector seats in military aircraft, quick release harnesses, wheels, front noses and steering wheels in motorsport but of course, they are very expensive. Chassis built utility vehicles have often been bolted together when repairs and part replacement have been considered a necessary design requirement. With the introduction of monococ construction in the 1950's welded panelled construction provided low cost structural stiffness in the shell. Lightweight, spaceframe vehicle construction have been made possible by the more recent developments of metal processing techniques like tube and sheet hydroforming and the availability of ultra high strength steel. Modular construction based on platform architecture has virtually killed off the tier half supplier by allowing OEM's to have in-house build flexibility on their assembly lines, switching models on a vehicle by vehicle basis.

The move toward the use of aluminium bodies for some luxury vehicles was made possible largely through the take up and development of the self piercing rivet.

What Next?

Irrespective of the type of future propulsion system, the driver/driverless vehicle, the pod or bus concept, every unit of motorised transport will ultimately need to be scrapped.

Over the last 20 years the reality of the 'China Price' has caused a fundamental shift in the public expectation and appreciation when purchasing goods. Today, because they are low cost, items which were once bought occasionally and then reused, are now considered disposable.

Market value dictates that what is made for sale has significantly greater worth than that which is unwanted. Yet, this principle is only based on having a customer who is prepared to pay. At the end of vehicle life, every person living on the planet will pick up some of the cost in the loss of resource which current disposal of an automotive unit entails.

All vehicles of modular construction			
Operations		Activities	Involvement
Strip down	1.	Remove all loose items (spare wheels etc.)	Tier 1
	2.	Steam clean and dry	VM
	3.	Palletise	VM
	4.	Remove wheels and closures	Tier 1
	5.	Remove interior elements	Tier 1
	6.	Remove engine and gearbox	VM
	7.	Remove suspension	Tier 1
	8.	Remove steering	Tier 1
	9.	Remove fuel lines	Tier 1
	10.	Inspect bodywork	VM
Rebuild	11.	Facelift body	VM
	12.	Replace fuel lines	Tier 1
	13.	Replace steering	Tier 1
	14.	Replace suspension	Tier 1
	15.	Replace engine and gearbox	VM
	16.	Replace interior	Tier 1
	17.	Replace wheels and closures	Tier 1
	18.	Inspect and test	VM
	19.	Drive out	VM

Figure 4. Idealised Remanufacture of Class A & B

Yet the actual value of many of the materials of every scrapped vehicle remains the same as the day it was assembled, only the function having changed. If only a small fraction of the resources which went into establishing the competitiveness of the product were to be spent in finding ways to recover that investment at the end of the life, the rewards could be highly profitable and long term. The increasingly complex mix of dissimilar lightweighting materials only compounds the current problem, suggesting a new approach is required.

One of the few truisms of life lies in the phrase, 'Great minds think alike.' Around the world people who have come up with the same ideas have done so independently because they were trying to solve the same problem. Any patent agent will inform that every invention has two elements, one being the problem, the other the solution. So I offer this challenge to those working in the fastener industry and elsewhere to find low cost methods of fastening which can meet the automotive industry's needs for an almost zero cost of disassembly. If it was easy, then it would already exist. Since it doesn't, imagine the commercial rewards which could come to those who solve the problem and the untold benefits which such an invention could provide across the whole industrial world and for every person on the planet.

This author can only suggest the problem. Perhaps you can help solve it?

Sources

(1) *Y Wang, J Teter, D Sperling, 2011, 'China's soaring vehicle population: even greater than forecast?" Energy Policy, 39(6): 3296 – 3306.*

(2) *Dr. Peter Standring, 'A New Paradigm for a Sustainable Automotive Industry', Proceedings of International Conference, 'New Developments in Forging Technology', Stuttgart, Germany, 12th – 13th May 2009 (This paper is available on the IMfT website at www.imft.co.uk).*