

EVS30 Symposium
Stuttgart, Germany, October 9-11, 2017

Borderless World: 2.0

Peter Wells¹, Liqiao Wang²

¹ (corresponding author) Centre for Automotive Industry Research, Cardiff University, wellspe@cardiff.ac.uk

² Centre for Automotive Industry Research, Cardiff University

Abstract

This paper examines the implications for future industrial structure of the introduction of electric vehicles bundled into new technology and service packages via connectivity, autonomous or assisted driving, and shared vehicle uses. It argues that the traditional automotive industry faces profound change as it coalesces with the information and communications technology industries. These changes are contextualised in the paper around the wider changes underway in the development of smart cities and seamless personal mobility provision across multiple modes and across public-private provision. One key mechanism identified in the paper is that of ‘quasi-diagonal’ integration, potentially a rapid but also unstable means of sharing competencies across industry boundaries. The paper defines alternative forms of quasi-diagonal integration mechanism, including strategic alliances, equity joint ventures, and micro-networks, and compares them with mainstream horizontal and vertical integration strategies within existing industry sector boundaries. The paper identifies all reported examples of quasi-diagonal integration by some of the leading vehicle manufacturers, including those examples that have failed, in order to provide an overview of the extent of activity and the different forms that such integration can take. It is concluded that quasi-diagonal integration is both highly prevalent and yet also particularly problematic as a corporate strategy, but is expedient given the rapidity of change in the operating environment. It is concluded that quasi-diagonal integration is pursued as a means of accessing complementary capabilities while retaining control of the value chain, and is often associated with new business models.

Keywords: Market development strategies; industry forecasting; business model innovation; mobility as a service

1 Introduction

In 1990 Kenichi Ohmae, the management strategist and former senior partner at McKinsey and Co., launched his famous book ‘Borderless World: Power and Strategy in the Global Marketplace’ [1] in which he outlined his fundamental thesis: that the traditional spatial boundaries between countries and regions were being eroded by globalisation. Much of this process of globalisation did indeed come to pass, with the opening up of markets in India, China and elsewhere key to powering economic growth. In some respects however the world envisaged by Ohmae has not come to pass, with recent events such as the isolationist stance taken by President Trump in the US, and the decision by the UK to leave the European Union, both being indicators of a shift away from the relentless globalisation agenda of entities such as the World Trade Organisation.

Now, however, an even more profound process is underway. It is one that is less constrained by geographic boundaries and the particular interests of nation states. It is both destructive and creative, and entails the dissolution of industry boundaries – some of which that have remained intact for more than 100 years. Pechmann et al. [2] chart the impact of systemic and disruptive innovation on Renault just with respect to electric vehicle technology. Now, business model innovation combined with burgeoning capabilities and applications in a suite of technology realms, along with new challenges in terms of sustainability, economic instability and political convulsions are resulting in previously uncharted product-service market landscapes [3,4,5]. For brevity, the paper makes the distinction between the ‘old’ automotive industry (making and selling cars) and the ‘new’ automobility industry (selling personal private mobility). It is recognised as a crude distinction, but is used as a shorthand for the sweeping transition underway. The ‘automobility industry’ is a radically different proposition than the monolithic global automotive industry foretold by Kenichi Ohmae. Indeed, while Ohmae may be somewhat perturbed by the re-emergence of geographical boundaries and borders – most obviously exemplified by the proposal by President Trump to build a physical wall to separate the US from Mexico – the technological transition of the automotive industry appears to be more substantial and enduring.

The brave new world of automobility services is typified by the Daimler strategy of “Connectivity, Autonomous, Sharing, and Electric” (see [6]) but it is the transition to that world that is fraught with complexity as the old certainties crumble [7]. Apple has reportedly experienced immense difficulties, with its Project Titan effort to develop an Apple Car riven by internal management strife and perhaps a growing awareness of the difficulties of car manufacturing [8]. The reports of the problems encountered by Google are strangely similar [9]. Tesla, despite showing that it is possible to be a ‘new entrant’ into the global automotive pantheon, has also struggled with returning profit while investing in growth, and with some high-profile incidents with the Autopilot system. Meanwhile, mainstream vehicle manufacturers have not seen electric vehicle sales match expectations (see for example [10]), and have proven rather more cautious about the introduction of autonomous technologies.

Hence the quest to bring electric vehicles to the mass market is intimately bound into wider structural changes around themes such as market fragmentation, smart urbanisation, connectivity, big data, car sharing and mobility as a service, automation of driving, and the very real prospect of ‘peak car’ occurring sooner rather than later. Crucial competitive battles await around questions of control over technologies, channels to market, and customers and the information explosion that underpins the transition to automobility.

This paper proposes that vehicle manufacturers are engaged in quasi-diagonal integration as an intermediate-term strategy to manage corporate risk given the levels of volatility and uncertainty in the transition to automobility. With a focus mainly on the established vehicle manufacturers, the paper identifies and analyses the reasons for quasi-diagonal integration, the specific formats adopted, and the potential consequences. The paper starts with a discussion of the dissolution of industry boundaries.

2 The dissolution of industry boundaries

We are used to talking in terms of ‘industries’ as cohesive entities in which it is clearly possible to place a company inside or outside, or a product as inside or outside. The automotive industry is a good example of such clarity, and a range of metrics then develop to define the relative size of the industry and of the participants: for example in the automotive industry a key measure remains the number of cars sold per annum. In systems terms, the automotive industry is a settled structure, nested at the core of a set of reinforcing elements, norms and expectations that collectively define a dynamically-stable whole. It is proposed here that quasi-diagonal

integration arises out of, and then further instigates, endogenous and exogenous forces for change that collectively and cumulatively act to undermine that dynamic stability by eroding the boundary certainties. We frame this as a transition from the automotive industry to the automobility industry.

Contextually, there is a tension between the need for consolidation and standardisation in traditional vehicle manufacturing, and the need to cope with an accelerating process of market fragmentation that is accompanying the transition to automobility. Industrial restructuring has traditionally taken four major forms: diversification into essentially unrelated domains; the development of new internal competencies; vertical integration into the supply chain or distribution chain; and horizontal integration whereby competitors are absorbed into larger entities to generate economies of scale. Digitization has, however, added a further form of industrial restructuring in which the core product (in this case, cars) is undergoing fundamental alteration as a technology and consumer proposition, and at an unprecedented pace [11]. As an industry, this means that the automotive sector is increasingly concerned with re-defining what is 'in' the sector and what is not. That is to say, the boundary edges of the sector are getting blurred. The new industry is often portrayed as an emergent 'ecosystem' of automobility services, as if it is a cohesive entity, but in practice the boundaries of the existing automotive world overlap with a growing number of other worlds in electricity generation and distribution, in artificial intelligence, in mobile communications, in big data, mapping and real-time information provision for example [12]. Companies facing this uncertainty and turbulence may seek a range of 'protection' strategies; Pinske et al. [13] identify 'collaboration-integration' as one such strategy, but do not elaborate greatly on how such collaboration-integration is to be achieved. For the vehicle manufacturers and their leading suppliers that constitute the core of the current automotive industry there is the twin challenge of how to maintain the existing business (invest in new plants and models; close down plants no longer needed; manage existing supply chains; retain brand positioning, etc.) while simultaneously deciding how far to proceed with these burgeoning new requirements that come with the transition to automobility, with whom, where, and on what basis.

New portfolios of competence and business model innovation will be required, both from traditional automotive industry players and new entrants, with considerable scope for synergies. Experienced automotive industry players that understand the cost pressures in the industry are often best-placed to leverage new technologies into mass production, but may need to access new skills and assets in these technologies through acquisition, alliances or organic growth. It is argued that one consequence is that traditional strategies of vertical or horizontal integration within an industry are of decreasing utility. In effect, automobility services built around electric, connected, shared and autonomous vehicles demand and arise out of the confluence of two or more industry sectors as the industry boundaries dissolve. In this sense themes such as autonomous cars are not simply definitions of a product, but also a process which can be understood as seeking to bring together disparate entities [14]. One way of managing this process is to create diagonal relationships across industry sectors. Thus diagonal integration may be defined as the direct acquisition of new competencies in any part of the emergent automobility services ecosystem. These integrational relationships are not easy: the example of BMW and Apple is illustrative [15]. Alternatively, traditional rivalries may be set aside as in the case of BMW, Mercedes and Audi co-purchasing Here from Nokia. Quasi-diagonal integration (QDI) may be defined as the less stable, more expedient (and possibly lower immediate financial risk) version in that the integration process falls short of outright ownership, but is more than the mere purchase of components or services. QDI is thus one mechanism by which network innovation may be achieved [16]. This is because QDI relationships emerge out of and are part of the process of creating shared cognitive framings of emergent phenomena, and may be expected to be more prevalent when new contexts or requirements are present. The cognitive framing for emergent technologies such as those required for the autonomous car, or shared car, or even electric car, is thus understood as the mechanism by which innovation can be orchestrated within a network through the medium of QDI relationships.

We can define several propositions regarding quasi-diagonal integration for vehicle manufacturers, which can then be tested against the available evidence:

- QDI will occur in situations of rapid technological or market change which includes pressures and threats that are exogenous to the existing industry;
- Vehicle manufacturers will create portfolios of QDI relationships in order to accelerate the creation of the new automobility ecosystem.
- Portfolios of QDI relationships will be asymmetrical from one vehicle manufacturer to the next, depending upon their respective starting points in terms of embedded capabilities, brand positioning, and strategic priorities.
- Portfolios of QDI relationships will form part of the strategy by which vehicle manufacturers seek to differentiate themselves and compete, but this may mitigate against wider standardisation.
- Vehicle manufacturers will not be entirely in control of QDI relationships, and in some instances may be the 'junior' partner.
- Vehicle manufacturers may use QDI relationships to exclude other vehicle manufacturers from a resource or capability.
- QDI relationships may be unstable due to shifting priorities, market or technology failures by one or more of the parties concerned, cultural incompatibilities, and other reasons.

As the research is currently exploratory in nature, we do not seek to test all the propositions in this paper, but rather to suggest a wider research agenda that tries to explain the breadth and diversity of relationships emerging across industrial sectors in general, and the automotive sector in particular.

3 Quasi-diagonal integration networks with vehicle manufacturers

This section provides evidence of the relationships entered into by vehicle manufacturers with e.g. mapping companies, search engine companies, public transport authorities, and others involved in dissolving the boundaries of the sector. A more detailed case study of Volvo is provided to illuminate the themes.

A key issue here is how to illustrate the propositions outlined in section 2. The emergent automobility industry is not yet a strongly interlinked network or system of parts that positively reinforce the long-term viability of the whole in the manner that has served the automotive industry for so long. Rather, what becomes evident from examination of the QDI relationships formed by the vehicle manufacturers is that there is a tendency to form exclusive clusters or micro-networks of QDI relationships in a fluid and dynamic manner.

Diagram 1 seeks to illustrate the pattern of relationships formed in which this exclusivity emerges. It is a partial, incomplete illustration as not all the data has been added yet, but still there is a sense in which there are differences in strategy and activity among the various vehicle manufacturers, and indeed those that would be participants in the new automobility industry.

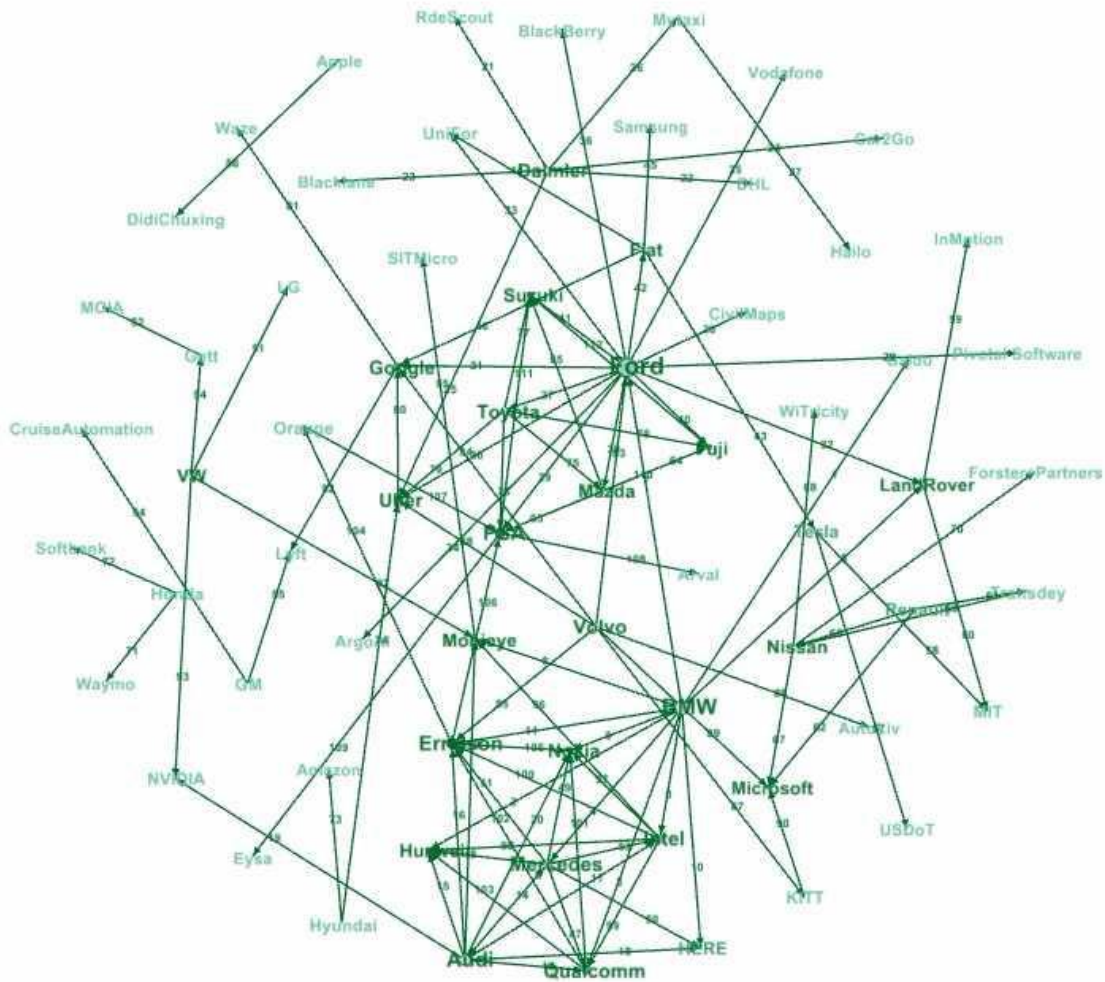


Diagram 1. Cluster networks in the emergent automobility industry

To tease out more detail, Volvo is used as a case study. This vehicle manufacturer is interesting as it illustrates both the unique characteristics of each vehicle manufacturer in terms of context, brand history, available options and so forth, but also some generic outcomes that might apply more broadly. In terms of the generalizable propositions defined in section 2, Volvo does indeed exhibit several QDI relationships that push against the boundaries of the traditional automotive industry sector. Table 1 provides a summary of these relationships for Volvo.

Company	Date	Item
Siemens	31/08/11	Joint development of electrical drive technology, power electronics and charging technology as well as the integration of those systems into Volvo C 30 Electric cars. Models shown in 2014. In 2013 the two companies showed a novel superfast charger. The PHEV XC90 in 2016 used Siemens electric motors.
Microsoft	11/11/15	Collaboration for the first automotive application of HoloLens technology: an untethered holographic computer. In 2016 introduced remote voice control for Volvo cars via the Microsoft Band 2 as another proof-point

		in their ambition to jointly develop next generation automotive technologies.
Uber	18/08/16	Combined US\$300m investment in autonomous technologies
Autoliv	06/09/16	Set up a joint venture company with Autoliv to accelerate the development of advanced driver assistance technologies and autonomous car technologies.
LG Electronics	04/11/16	Proposal (not verified) to enter into wide-ranging agreement for the co-development of components and systems for electric cars and autonomous cars.
Nvidia; Autoliv	27/06/17	Plan to develop software systems for self-driving cars; to develop systems that use artificial intelligence to recognize objects around vehicles, anticipate threats and navigate safely.

(Sources: [5,17,18])

Table 1. Volvo and quasi-diagonal integration

An important starting point in terms of autonomous car technology for Volvo has been the long-established relationship with Tier 1 supplier Autoliv. This relationship helped form the basis of the joint venture business announced in September 2016 of which the CEO Hakan Samuelsson said:

“By combining our know-how and resources, we will create a world leader in AD software development. This means we can introduce this exciting technology to our customers faster.” (Cited in [18]).

Volvo Cars became part of the Geely Group (China) in 2010, having been sold by Ford. The link with Nvidia is key to the effort to develop autonomous cars. Nvidia, also has partnerships with Toyota, Audi and Mercedes. Meanwhile, in a separate cluster, BMW has relationships with Intel (US) and Mobileye (Israel, with expertise in vision systems and mapping), with a similar aim of developing autonomous cars. Moreover, Delphi and Continental, both traditional automotive suppliers, have since joined the BMW cluster. Interestingly, although Daimler (owner of the Mercedes brand) has links with Nvidia, it also has fostered a relationship with Robert Bosch with a focus on autonomous cars. To further complicate the picture, Bosch itself is developing capabilities in ‘new’ markets such as short-term motorcycle rental. According to Board Member Rolf Bulander:

“While there are market segments where we are clearly a supplier, there are markets which are not yet developed where new players are emerging, this includes us.” (Cited in [19], 2017).

Furthermore, in 2017 Ford, in an almost- traditional acquisition move, has planned to invest US1 billion over 5 years into Argo AI, a start-up company in the US specializing in artificial intelligence, a technology which is widely held to be vital if cars are to reach Level 5 autonomy [20]. It is notable that Jaguar Land Rover has in 2017 announced the intention to recruit an additional 5,000 engineering employees, of which at least 1,000 would be in software and electronics [21]. In this it is evident that there are multiple strategic options available to the automotive industry, but no uniformity of solutions.

In other words, the case of Volvo is illustrative of a wider trend: many of the companies that comprise the ‘borderless’ automobility industry are themselves becoming less distinct but such a ‘rule’ is not absolute and need not apply to all aspects of the emergent automobility industry. Therefore the Volvo case is illustrative of a

form of semi-exclusive micro-network of QDI and other relationships that in effect form a new cluster of competences in which Volvo seeks to retain a central role.

4 Analysis: the transition to automobility

This section explains the implications of the full transition to automobility for the traditional vehicle manufacturers as business models and customer relationships are redesigned around mobility provision. It is contended that such a transition erodes the borders of the automotive industry and the struggle is over control of the customer relationship. It is illustrative that Daimler CEO Dieter Zetsche said:

"Google and Apple want to provide system software for cars and bring this entire ecosystem around Apple and Google into the vehicle. That can be interesting for both sides... (but) We don't want to become contractors who have no direct contact with customers any more and supply hardware to third parties." (Cited in [22]).

Much of this transition is uncertain, from the underlying technologies to the expected demand [23]) but the structural and business model innovations already evident with respect to EVs [24] are being compounded by the additional demands of connectivity, automation and sharing. Consensus roadmaps [25] are of limited utility in fostering this new borderless world of automobility. Such roadmaps may help identify where technological 'trajectories' are likely to lead, and identify key 'gaps' that require more R&D. The roadmaps may also be the basis upon which some classes of QDI are created: notably in terms of collaborative projects funded by governments with the intention of creating new areas of competence. This process is clearly evident in the UK, where the Automotive Council has worked closely with government funding agencies such as Innovate UK to then design guided programmes of research, which in turn increases the capacity of the industry in the emergent technologies [26].

Still, creating technologies is only part of the issue in the transition to automobility. It is evident in the case of Volvo that in relationships with entities like Nvidia the vehicle manufacturer is seeking to leverage the historic brand association with safety by augmenting the technologies needed for fully autonomous vehicles. The company is also leveraging historic relationships with Tier 1 automotive suppliers, in this case Autoliv, just as other vehicle manufacturers are seeking to do. It is interesting to note that in Table 1 the relationship with Siemens, an established supplier to the automotive industry, goes back to 2011, and has evolved through several successive stages. It means that elements of the QDI relationships may not necessarily be unstable and short-term, at least where there is mutual benefit. In contrast, the QDI relationships with Uber, and with Nvidia, are recent and essentially untested. If Uber has a long-term interest in autonomous cars to replace drivers in its taxi fleet, perhaps the company also has an interest in more of a 'commodity' approach to the car as a product, which seems contrary to the desire of Volvo to retain brand distinctiveness. Volvo has stated the intention to produce autonomous vehicles for the luxury market [27], with the 'Autopilot system adding US\$10,000 to the cost of the car. According to Hakan Samuelsson, CEO at Volvo Cars:

"To make a car even more premium, one of the most interesting things is a full autopilot...Not a supervised version, but really the one that you can sit back and watch a movie or whatever. That will make the premium car even more premium." (Cited in [27])

The assumption in the academic literature is that firms engaged in integrating across knowledge fields seek to maintain their distinctiveness and independence while simultaneously gaining knowledge transfer [28]. However, in the highly contested and turbulent context outlined in this paper it is by no means certain that such mutually beneficial outcomes will obtain. To underline the concern with commodification, it is also clear that for Samuelsson at Volvo Cars the potential of autonomous car technologies is clear:

“If you’re only providing transportation from A to B, you’re heading into trouble... You still need to have a car that is not just fulfilling the transportation need, but also giving our customers an emotional value, a premium car.” (Cited in [27])

In this quote Volvo is pursuing a distinct interpretation, or framing, of how the company seeks to understand and then capitalise on the integration of autonomous technologies in a particular way. Similarly, in the work with Siemens on electric powertrain, Volvo has sought bespoke rather than off-the-shelf technology solutions in items such as electric motors with the view that such solutions will assist in retaining the brand distinctiveness of the cars and hence the ability to recover costs from the market. The strategy is further underlined by the decision to develop the ‘Polestar’ branding for the luxury segments to compete with cars from companies such as Tesla and BMW.

5 Conclusions

The paper concludes that quasi-diagonal integration is the new normal for what was the automotive industry, and that ultimately fewer but larger automobility companies will dominate the market in the future. There is a distinct pattern of emergent ‘clusters’ in which some of the companies are pursuing a shared-destiny and exclusionary approach. In this respect there is a ‘hybrid’ strategic solution that lies in between internal, company-specific solutions, and industry-wide solutions [29]. In turn, it might mean that the lack of single dominant solutions will create the space for greater levels of product innovation [3]. The overall strategy of the vehicle manufacturers appears to be one of seeking to retain their traditional brand leadership, control of the product, and contact with the customer. It is by no means self-evident that such a strategy is viable for all of the existing vehicle manufacturers in the future.

References

- [1] Ohmae, K. (1990) *Borderless World: Power and Strategy in the Global Marketplace*, London: Harper Collins.
- [2] Pechmann, F. von; Midler, C.; Maniak, R. and Charue-Duboc, F. (2015) Managing systemic and disruptive innovation: lessons from the Renault Zero Emission Initiative, *Industrial and Corporate Change*, 24(3), 677-695.
- [3] Gao, P.; Hensley, R. and Zielke, A. (2014) A road map to the future for the auto industry, *Mckinsey Quarterly*, October, 1-11.
- [4] Viereckl, R. et al. (2016) *Connected car report 2016: Opportunities, risk, and turmoil on the road to autonomous vehicles*, Price Waterhouse Coopers, <https://www.strategyand.pwc.com/reports/connected-car-2016-study>, Accessed 11th November 2016.
- [5] CB Insights (2017) 44 Corporations Working On Autonomous Vehicles, <https://www.cbinsights.com/blog/autonomous-driverless-vehicles-corporations-list/>, Accessed 8th July 2017.
- [6] Daimler (2016) New strategic orientation Mercedes-Benz Cars reinvents itself <https://www.daimler.com/innovation/specials/electric-mobility/case.html>, Accessed 17th November 2016.

- [7] Ruff, F. (2015) The advanced role of corporate foresight in innovation and strategic management — Reflections on practical experiences from the automotive industry, *Technological Forecasting and Social Change*, 101, 37-48.
- [8] Macrumors (201) Apple Car: Apple's vehicle project, focused on building an autonomous driving system, <http://www.macrumors.com/roundup/apple-car/>, Accessed 17th November 2016.
- [9] Curry, D. (2016) What's happening with Google's self-driving car project? <http://readwrite.com/2016/09/03/google-self-driving-troubles-t14/>, Accessed 17th November 2016.
- [10] Loveday, E. (2016) Soft Demand Limits BMW i3 Sales, <http://insideevs.com/soft-demand-limits-bmw-i3-sales/>, Accessed 17th November 2016.
- [11] Ardolino, M.; Saccani, N. and Perona, M. (2015) The Impact Of Digital Technologies And Ecosystems On The Servitization Of Companies: A preliminary Analysis. In Proceedings of the Spring Servitization Conference.
- [12] Schulze, A.; MacDuffie, J.P. and Täube, F.A. (2015) Introduction: knowledge generation and innovation diffusion in the global automotive industry—change and stability during turbulent times, *Industrial and Corporate Change*, 24(3), 603-611.
- [13] Pinske, J.; Bohnsack, R. and Kolk, A. (2014) The Role of Public and Private Protection in Disruptive Innovation: The Automotive Industry and the Emergence of Low-Emission Vehicles, *Journal of Product Innovation Management*, 31(1), 43-60.
- [14] MacDuffie, J.P. (2013) Modularity-as-Property, Modularization-as-Process, and 'Modularity'-as-Frame: Lessons from Product Architecture Initiatives in the Global Automotive Industry, *Global Strategy Journal*, 3(1), 8-40.
- [15] Taylor, E. and Love, J. (2015) Apple, BMW in courtship with an eye on car collaboration, <http://www.reuters.com/article/2015/07/31/us-apple-bmw-courtship-insight-idUSKCN0Q52CW20150731>, Accessed 6th August 2015.
- [16] Johansson, M. and Deniz, S. (2014) Ecosystem Changes in the Automotive Industry: Electric Vehicles and the Increased Importance of Network Business Models. In European Electric Vehicle Congress Brussels, Belgium, 3rd–5th December.
- [17] Lee, S-H. and Park, C-Y. (2016) Volvo may link up with LG Electronics to develop future cars, <http://pulsenews.co.kr/view.php?sc=30800021&year=2016&no=770991>, Accessed 10th November 2016.
- [18] Volvo (2016) Volvo cars and Autoliv to create joint venture for autonomous driving, Volvo Cars PR, Press Release, 6th September 2016.
- [19] Rehle, W. (2017) Bosch says demand for driver assistance systems taking off, <http://uk.mobile.reuters.com/article/businessNews/idUKKBN19P0UG>, Accessed 7th July 2017.
- [20] Marshall, A. (2017) Eyeing a self-driving future, Ford drops \$1b on an AI startup, <https://www.wired.com/2017/02/eyeing-self-driving-future-ford-drops-1b-ai-startup/>, Accessed 2nd July 2017.
- [21] Allen, K. (2017) Jaguar Land Rover to recruit 5,000 staff after record year of sales, <https://www.theguardian.com/business/2017/jun/18/jaguar-land-rover-to-recruit-5000-of-staff-after-record-year-of-sales>, Accessed 2nd July 2017.
- [22] Cremer, A. (2015) Daimler CEO mulls JVs with Apple, Google, <http://www.reuters.com/article/us-daimler-ceo-idUSKCN0QQ18D20150821>, Accessed 25th August 2015.
- [23] Hinkeldein, D.; Schoenduwe, R.; Graff, A. and Hoffmann, C. (2015) Who would use integrated sustainable mobility services-and why? *Transport and Sustainability*, 7, 177-203.
- [24] Weiller, C.; Shang, T.; Neely, A. and Shi, Y. (2015) Competing and co-existing business models for EV: Lessons from international case studies, *International Journal of Automotive Technology and Management*, 15(2) 126-148.

- [25] Holweg, M. (2014) Where firm-level innovation and industrial policy meet: Consensus roadmaps for low-carbon powertrain technologies, *Journal of Product Innovation Management*, 31(1), 33-42.
- [26] Chase, A.; Wells, P. and Alberts, G. (2016) UK low-carbon automotive investment: the role of policy in the UK automotive sector renaissance, *Engineering and Technology Reference*, doi: 10.1049/etr.2015.0069: pp1-8.
- [27] Naughton, K. (2016) Volvo Plans to Offer Fully Self-Driving Car to Luxury Buyers, <https://www.bloomberg.com/news/articles/2016-09-29/volvo-plans-to-offer-fully-self-driving-car-to-luxury-buyers>, Accessed 8th July 2017.
- [28] Schulze, A.; Brojerdi, G. and von Krogh, G. (2014) Those Who Know, Do. Those Who Understand, Teach. Disseminative Capability and Knowledge Transfer in the Automotive Industry, *Journal of Product Innovation Management*, 31(1), 79-97.
- [29] Gawer, A. and Cusumano, M.A. (2014) Industry Platforms and Ecosystem Innovation, *Journal of Product Innovation Management*, 31(3), 417-433.
- [30] Brem, A.; Nylund, P.A. and Schuster, G. (2015) Innovation and de facto standardization: The influence of dominant design on innovative performance, radical innovation, and process innovation, *Technovation*, 50-51, 79-88.

Authors



Peter Wells is a Professor of Business and Sustainability at Cardiff Business School and Co-Director of the Centre for Automotive Industry Research where his work has ranged across spatial industrial development, economics, organisational theory, industrial ecology, technological change, transitions theory, business models and sustainability. Professor Wells has over 700 publications reaching academia, industry, policymakers and stakeholders through traditional academic papers and books, industry practitioner journals and events, internet publications and, more recently, webinars. 'Business models for sustainability' (Edward Elgar, 2013), and 'The global automotive industry' (edited with Paul Nieuwenhuis. John Wiley, 2015).



Liqiao Wang, a current first year PhD candidate in Cardiff University who supervised by Professor Peter Wells. Her study area is about autonomous, connected and shared vehicles with an application of Socio-technical transitions theory. She has qualified MSc Logistics Management and MSc Social Science Research Methods recent years.