Temporal Stakeholder Analysis of Future Technologies:
Exploring the Impact of the IoV

by Carl Adams, Amanda Pert, Penny Ross, and Benjamin Aziz

MAPPING THE FUTURE

Rowan Gibson, a strategy consultant with the Rethinking Group, argues that we are going through an unprecedented level of technological change, which is forcing businesses and society to continually reassess their current state and rethink how they manage their place in the future world. Gibson argues that some action and forethought is needed, as "the lesson of the last three decades is that nobody can drive to the future on cruise control."[1]

That said, it is problematic to try to guess where future technology will take us, as Bernd Stahl, director of the Centre for Computing and Social Responsibility at De Monfort University, notes:

> Briefly, we can know neither future information technology nor any of the other aspects of the future. At the same time, however, we need to make decisions based on assessments of the future that will then, in turn, influence the way the future will turn out in practice.[2]

A further problem is that technology and the people who use it often have a habit of surprising us. People use technology in unexpected ways, business and social processes change in unexpected ways, and the technology enables new sets of users to emerge — again using the technology in ways it was not designed for. Michael Arnold of the University of Melbourne, Australia, cites auto safety measures as one example of the paradoxical nature of technology. Automakers improved car brakes in order to make driving safer; however, having improved brakes on a vehicle often causes drivers to change their behavior, such as driving faster and closer to other vehicles. This reduces the "thinking" component of stopping time and, consequently, can make driving more dangerous.[3] Another example Arnold cites is antibiotics, which were developed to kill pathogens and reduce disease. However, their success led to overuse, which in turn has resulted in pathogens evolving into resistant strains that limit the effectiveness of antibiotics.[4]

Some prior consideration of the impact of these technologies might have prompted the parties concerned to take steps to reduce the potential risks. In the case of the improved brakes, automakers might have developed complementary vehicle technology, such as proximity-sensing and warning systems. Medical policymakers might have encouraged more sparing use of antibiotics rather than treating them as a panacea for all ailments.

As the above examples show, we are in a Catch-22 situation. While it has become increasingly important to consider the potential impact of future technologies and plan for opportunities and risks, it is difficult to predict what technologies will become dominant, how people will interact with them, and what corresponding risks may emerge. Business and societal leaders need practical tools to help with this exploration in order to avoid unexpected technology backlash.

TOOLS OF THE IMPACT ASSESSMENT TRADE

There are many tools and techniques for exploring and investigating the impact of technology, and evaluations are often performed as part of the risk assessment process, such as those recommended by the standards bodies. For instance, the ISO 9001/3 and related ISO 31000 provide guidance on conducting risk assessments and managing risk that explicitly covers assessing risks associated with technologies (although their focus is, admittedly, on the adequacy of current controls within an organization). Here we outline some of the technology assessment methods currently in use.

Participative Technology Assessment (pTA)

One main theme in most forms of technology impact assessment is the involvement of different experts and stakeholders. For instance, Stahl suggests using Participative Technology Assessment (pTA) methods,[5] which incorporate early thinking on technology assessments developed in the 1960s by the US Office of Technology Assessment, but also include consideration of more socio-technological issues and the involvement of multiple stakeholders. A key benefit of using a participatory process to capture the views of multiple stakeholders is that it can help its users develop pragmatic perspectives on how a technology may evolve, such as who would use it, how they would use it, and what clashes of use between different stakeholder groups might arise. It can also help practitioners identify possible risks and dangers of various technological options and so determine those that should be encouraged and those that should not.

When assessing technologies that are not yet available, it is not always clear who the full set of stakeholders is likely to be. However, it is still useful to contemplate the possible impact of the future technology, including identifying potential stakeholder groups that *could* be affected.

Future Analysis (FA)

The Future Analysis (FA) assessment tool, which addresses the dynamic nature of requirements in ICT, likewise uses a multidisciplinary team to identify possible changes in a system. Developed by Frank Land[6] of the London School of Economics and Political Science, FA classifies the potential areas for change into major categories of technology, legal requirements, economic/environmental factors, and attitudes and expectations within the organization. It also develops a basic scenario of the future to try to assess the kind of future the ICT would have to face. The output, Land claims, is a prediction of possible scenarios and greater insight into the dynamic environment of a new ICT development.

Scenarios and Use Cases

The scenario approach has been widely used to assess possible future operating environments for businesses, industries, and society.[7, 8] "General" future scenarios are used to capture likely large, structural changes. Sometimes more depth is needed, so the general scenarios are used as the base for developing more specific use cases that detail instances of a particular use of a technology in a particular context. Having more detailed scenario use cases helps evaluators consider and analyze specific uses in more depth, enabling a better understanding of how stakeholder groups will engage with the technology.

Temporal Stakeholder and Event Analysis (TSEA)

One approach that explicitly brings together the scenario/use case aspects, the involvement of different experts and stakeholder groups, and a temporal element (looking backward and forward) is Temporal Stakeholder and Event Analysis (TSEA).[9] TSEA draws upon the experiences of different stakeholder groups with previous technologies and applies that learning to a new technology or system. In this way, it provides a structure to capture the lifecycle of a technology/system and how it impacts stakeholder groups at each of the lifecycle stages.

TECHNOLOGY ASSESSMENT IN PRACTICE

Our Method

In the remainder of this article, we present and demonstrate a practical method we used to help assess the impact of a future technology on key stakeholder groups. The method is an impact assessment based around workshop sessions in which expert participants develop scenarios and detailed use cases of how a new technology could be used in real situations. The workshops use a temporal frame, looking back at previous similar technology introductions to briefly evaluate their lifecycle and how they impacted various stakeholders, as well as capturing any extended or unexpected uses of the original designs. This information is then used to help extrapolate how the new technology could affect stakeholders, exploring the wider impact and possible unintended consequences over the lifecycle of that new technology.

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We then demonstrate our impact assessment method by presenting the results of two workshops that explored the possible adoption of the Internet of Vehicles (IoV). The workshop sessions produced some interesting results that challenge some of the common value propositions that are being used to promote the development of the IoV.

Our Three IoV Use Cases

Use case examples are a good way to show how such an analysis of a future technology can be conducted. As noted, the future technology that we are considering is the IoV within the larger Internet of Things (IoT), an interesting set of technologies on the horizon that will have significant and far-reaching impacts on how societies function and interact.[10, 11] The scale of investment around the globe in the IoT and IoV is considerable, and many of the building blocks are already here.[12] For instance, at the Consumer Electronics Show (CES) in Las Vegas in January 2015, many of the car manufacturers from the US, Europe, and the Far East showcased their latest developments, including autonomous drive technologies and car-to-car communication systems.

There are many technical, business, and practical challenges in getting these very complex systems working to achieve the expected efficiencies and promised benefits — and this has been the focus of most IoT research and investment.[13] The IoV will probably be one of the most evident manifestations of the IoT for many people, with changes coming from a variety of factors, such as: environmental imperatives (the need for more efficient travel, higher vehicle density on road networks, reduced pollution, etc.), technological changes (driverless cars, more automation in cars), safety (accident reduction), and business advantage (having more reliable transport systems for delivery of goods and employees).[14, 15]

Based on these and other strong value propositions given for the IoV,[16, 17] we defined three distinct, detailed use cases to assess the potential impact of IoV adoption:

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Use Case 1: Automated Commuting Convoys and the Resulting Hours of "Extra" Time

A result of automated commuting will be that people will have "extra" time that was previously used to drive their vehicles. Commuting time can be considerable;[18] for many workers around the world, it amounts to an hour or more each way.

Use Case 2: Convoys Coordinating the Crossing of Road Junctions

This use case explores how the convoys/road trains will coordinate the traversing of road junctions so that vehicles don't need to stop. It also covers efficiencies in travel such as reduced air resistance in close-packed convoys.

Use Case 3: Handling of Road Disruptions

This use case covers breakdowns or obstacles on a road and how an autonomously driven vehicle would work out how to most effectively get around the obstacles. The main value propositions here relate to journey resilience (consistent road journeys, ability to handle disruptions and emergency situations, less stress for commuters and travelers, betters supply chains, etc.).

Our Workshops

Having developed the detailed use cases, we then critically evaluated them at two workshop sessions. To bring out more detail for each of the use cases, we asked the following questions about the likely application of the technology:

- How would each of the stakeholders interact with the system?
- How could communication be organized?
- Which entities would have responsibility for control of which parts of the system?
- Who would pay for what?

The workshops followed a mini living lab approach where ideas were raised, discussed, evaluated, and developed in small groups; the resulting ideas and issues were then combined together for a whole group evaluation. Each workshop consisted of 20-30 participants, including two groups of final-year students at the University of Portsmouth, one group in a highly technical computer science degree program and the other with a technology management focus. Academic staff with technology and management expertise also participated. Approximately 50% of the workshop participants were drivers. Part of the workshop activity was to consider and evaluate options from technology, practical, and business perspectives.

Participants were divided into groups of three to five people, and each of these small groups considered the detailed use cases and associated questions. They were also encouraged to "think outside the box" and develop their own questions on how the technology would be used and how it would impact wider stakeholder groups. The emergent discussions were captured by each group, typically on a large sheet of paper, sometimes supplemented with Post-It notes, though some groups also used electronic recording. The themes and discussion points were collated together at the end of the workshop with final discussion on the points and issues raised.

Afterward, the raw themes, discussion points, challenges, and so on collected from both workshops were hosted electronically so participants could view them and add further comments and feedback on the emergent issues. The team then collated the results of the emergent themes to develop a more thorough analysis for a report on the potential impact of IoV.

THE RESULTS

As we discuss below, one of the main results of our workshops was that for each of the use cases, participants uncovered a set of issues that challenged the value propositions used to promote IoV/IoT activity (e.g., improved commutes, reduced traffic jams, increased safety).

Use Case 1 — Automated Commuting

During the workshop discussions, three main commuter profiles emerged:

1. Worker-commuter
2. Social-commuter
3. Entertainment-commuter

There would likely be variations within these categories (e.g., different types of worker-commuters), and individuals could fit multiple profiles (e.g., sometimes a worker-commuter, sometimes an entertainment-commuter). The basic profiles are described in greater detail below:

The Worker-Commuter

This profile represents employees who use the commuting time for business activity, with the self-driving vehicle acting as a fully functioning traveling "office" space. This possibility prompted several discussions on how this would work in practice. One concern was that it would evolve into commuters being forced to extend their working time and environment to include the extra commuting activity, effectively resulting in employers getting more work out of their employees for no additional compensation. Alternatively, it could shorten the commuters' workday if they count the commuting time as valid work time. In such a model, the actual time spent commuting wouldn't be relevant to the efficiency of businesses, since employees could be productive at work or in the commuting state. So from a work perspective, it would not (necessarily) be a problem to be stuck in a long traffic jam; indeed, for some employees, being struck in traffic may enable them to be more focused on work activity than in the office environment.

Some participants observed that if the concept of the fully functioning traveling office was extrapolated, then some employees could dispense with the commute altogether and just work from home using their new "office space," be it in their vehicle or their home. The unintended consequence here was that having more technology to help the commuter get to work quicker and more easily may actually reduce the need for commuters to *get* to work. Where a faster commute is the primary goal, workshop attendees suggested that low-tech alternatives, such as coordinating commuting times to ensure minimal congestion (say, by changing the start and end of employees' workdays) might be just as or more effective.

The Social-Commuter

Workshop participants also considered what would happen if employees used an automated commute for social space and purposes. This raised many ethical and privacy issues regarding how people would use that social space and extra time, as well as the potential for misuse by other commuters, marketers, technology companies, and governments. After all, commuters will be trapped in a confined space, very much a captive audience, with much personal data being shared between vehicles and road furniture, such as journey details, insurance data, address information, passenger details, entertainment preferences, and so on.

Another issue that emerged in the discussions was the potential changes in social behaviors that may ensue. For instance, with people confined in a private space with free time on their hands, would we see the emergence of driverless commuter dating?

The Entertainment-Commuter

Alternatively, commuters could use the commuting time to watch a movie, listen to music, or eat breakfast. Clearly, we would see the emergence of new commuter-based business models in which marketers would look to cater to the preferences and needs of commuters with extra time on their hands. The potential for several unintended consequences was clearly evident in the discussions. The safer commuting originally envisaged by IoV proponents may turn into unsafe social practices, new avenues for security and privacy breaches (e.g., misuse of personal journey data), and new types of safety risk (e.g., increased risk of choking on or spilling hot food while eating breakfast in a moving vehicle).

Use Cases 2 and 3 — Coordinating Convoys at Road Junctions and Handling Road Disruptions

For the other two use cases, the discussions raised several issues around how coordination of autonomous vehicles would actually work in practice. For instance, participants noted that there would likely be different priorities for different types of vehicle traffic, such as high priority for emergency vehicles. Different types of vehicle convoys, say trucks and cars, may have different traveling capabilities, which would need to be factored into any coordinating methods. Discussions emerged around how to coordinate convoys of vehicles each with different capabilities, preferences, and priorities (e.g., some convoys may place a priority on quick journey time while others focus on economy).

Clearly, there would be some negotiation required between convoys to find the best coordinating option for traversing a junction or road disruption. Workshop attendees discussed the potential for paying for increased priority and, further, for "gaming" activity between convoys (i.e., attempts to get preferential treatment for a particular convoy). One possible unintended consequence discussed was that "better" coordination would likely not be applied equally to every set of road users, and thus we could see a different type of road rage emerge.

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WORKSHOP LESSONS LEARNED

The workshops, which were focused around a detailed set of use cases within a general IoV/IoT scenario, uncovered issues that policymakers should consider before the technology progresses too far. Clearly the challenges of IoV/IoT are not purely technical, and the impacts of the technology might not be those initially intended. The two workshop sessions captured critical perspectives that contested the value propositions often presented in the literature and reports covering IoV/IoT (e.g., that it will be safer and more resilient).

What Worked Well

The workshop approach using the living lab evaluation cycle, with opportunity for continued feedback and discussion of emergent themes, seemed a good way to conduct a technology evaluation using one of the participant/stakeholder approaches. It was quite cost-effective and produced timely results.

The temporal stakeholder analysis (looking backward at past technology and forward to similar patterns with new technology) within the workshop format likewise seemed to work well. Having groups with distinct expertise (technology and business; drivers and non-drivers) encouraged a wider analysis that yielded multiple perspectives. Both workshops generated many issues and points that require further investigation (more consideration of what people will do in self-driving commuting vehicles, their loss of personal control while in the vehicle, who pays for the road communication services, etc.).

What Could Have Worked Better

On reflection, it would have been good to record the live discussions, which were often quite rich as participants considered the implications of a particular use case. Similarly, it would have been useful to hold a follow-up workshop with the participants to further explore some of the interesting issues raised, possibly with representatives of other stakeholder groups identified during the workshop. For the participants in our study, we drew upon final-year graduate students supplemented with academic staff. Including different groups of participants may well have resulted in other issues and options emerging.

EVALUATING FUTURE TECHNOLOGY: WHEN? HOW OFTEN?

It is unclear how often such evaluations of future technology should be conducted. The Canadian *Privacy Impact Assessment* guidance recommends that government departments conduct a "PIA in a manner that is commensurate with the level of privacy risk identified, before establishing any new or substantially modified program or activity involving personal information,"[19] or specifically when there is new technology, substantial modifications to a system, new processes, or new uses of a technology. In addition to these scenarios, the guidance from standards frameworks suggests that risk assessments be done as a rolling scheduled process, say as part of the internal audit process (and, of course, as part of the standards accreditation process).

We believe that it is useful to do an assessment before a new or future technology is introduced. Much technological development is blinkered by a technological mindset that focuses on the innovation itself; the impacts and unintended consequences of a new technology are not considered until the technology is already with us.[20] Furthermore, technological change only seems to have "forward gears" — once a technology has been adopted, it is difficult to go back to a previous state or steer the direction of technological evolution down a different path. However, with a forewarning of issues and problems, it *is* possible to influence the direction of the development of technology early on, taking into account affected stakeholders and the wider community.[21] Our common future deserves no less.

ENDNOTES

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[20]Arnold (see 3).

[21]Adams (see 9).

Carl Adams is a Principal Lecturer/Researcher in the School of Computing, University of Portsmouth, UK. He had over a decade of professional experience as a software engineer, analyst, and consultant before going into academia. Dr. Adams's research interests explore the wider impact of the digital economy and include e/m-commerce, e/m-government, mobile information systems, social media, electronic money, and the impact of technology on society. He has over 100 peer-reviewed publications in journals and international and national conference proceedings as well as several book chapters and a book. Dr. Adams has been a keynote and invited speaker at conferences and workshops. He can be reached at carl.adams@port.ac.uk.

Amanda Peart is a Senior Lecturer in computer science within the School of Computing, University of Portsmouth, UK, where she predominantly researches and teaches in computer networks at all levels in the undergraduate program. Dr. Peart has held a variety of external examiner appointments for a number of universities. Her main area of research is the quality of service (QoS) in ad hoc wireless networks. Dr. Peart's research investigates techniques that provide a satisfactory balance for applications continually demanding higher bandwidths while the users demand better QoS in wireless environments with bandwidth, delay, jitter, reliability, and power challenges. She can be reached at Amanda.peart@port.ac.uk.

Penny Ross has been a Senior Lecturer in information systems at the School of Computing, University of Portsmouth, UK, for seven years. Dr. Ross's teaching areas are information systems management and advanced database concepts (for final-year students), while her main focus is in applied uses of information and information systems. She holds a Ph.D. in decision making in complex environments [from where?]. Dr. Ross's research topics have covered a broad range of environments, but the underlying core is analysis, understanding of complex systems, and the application of IS within these environments. Other projects include working with a city council to develop telecare systems to support the vulnerable and elderly within the city and evaluating the principles and procedures for development and implementation of a mobile telecare service. She can be reached at penny.ross@port.ac.uk.

Benjamin Aziz is a Senior Lecturer in computer security at the School of Computing, University of Portsmouth, UK. Dr. Aziz holds a PhD in formal verification of computer security from Dublin City University and has research experience in the field of computer and information security spanning 15 years. He has worked at Rutherford Appleton Laboratory and Imperial College London and has published more than 80 articles and book chapters in areas related to the security of large-scale systems, formal security, requirements engineering, and digital forensics. Dr. Aziz is on board program committees for several conferences and working groups, such as ERCIM's FMICS, STM, Cloud Security Alliance, and IFIP WG11.3. He can be reached at benjamin.aziz@port.ac.uk.