The APMA's Connected Car Project: Innovation through Collaboration in the Canadian Automotive Parts Industry

by **Ata-ul Munim**,
APRC Industry Research Assistant

and

Dr. Charlotte A.B. Yates,
APRC Principal Investigator

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Executive Summary

Collaboration is a key driver of innovation in knowledge-based economies and sectors that are increasingly becoming technologically complex, such as the automotive industry. However, collaborative activities are faced with a number of organizational and financial hurdles which impede their effective functioning. This report undertakes an in-depth study of a successful collaborative program in the Canadian automotive industry, known as the Connected Vehicle Technology Showcase or the Connected Car project. Through interviews with the key partners, including those in the Connected Vehicle Working Group (CVWG), a number of best practices and lessons learned have been identified. These include: common goal and vision, project management, leadership, communication, organizational cultures, and funding. We also explored the role of government policy vis-à-vis funding and support of the Connected Car project and other similar collaborative projects.

Introduction

The automotive industry is an integral part of the Canadian manufacturing sector and by that token Canadian economy. It contributes over $20 billion to the Canadian GDP, directly employs upwards of 120,000 people and is the second largest contributor to manufacturing GDP. In addition, the automotive industry provides significant multiplier and spin-off benefits.[1] Empirical studies suggest that for every one assembly job, nine others are created in upstream and downstream activities. Consequently, an additional 280,000 Canadian jobs depend on automotive manufacturing.[2] The automotive industry is also a significant net contributor to Canada's trade balance. In 2013, the total exports in the automotive sector were $68 billion, which accounted for 14 per cent of Canada's merchandise export in that year.[3]

The 2008-09 recession had a significant negative impact on the Canadian automotive industry. While the industry has rebounded from the downturn, it faces a number of challenges and pressures including increased global competition, new global and regional trade regimes, pressing environmental issues and standards, and fluctuations in the value of the Canadian dollar. These issues have contributed to an economic environment much different, and arguably much more challenging, than the one faced by the industry when the Auto Pact was negotiated in the 1960s and even prior to the 2008-09 global recession. This highly competitive global environment means that the Canadian automotive industry must continuously evolve and innovate in order to remain competitive.

Amidst increasing international competition and rapid technological change and complexity, collaborations and partnerships between private industry, academia, government and other organizations play a central role in driving innovation and economic growth in a knowledge-based society. Growing technological complexity and rising research costs have led to an increasing focus on collaboration as a strategy for innovation and growth. Advances in information technology have also created expectations that an increasingly wide range of problems can be researched and addressed in a more holistic fashion and at an accelerated pace. Governments in OECD countries have increasingly focused on partnering with both universities and

1. Brendan Sweeney, *APRC Canadian Automotive Manufacturing Industry Profile 2014* (Hamilton, 2014), 1.
2. Ibid.
3. Statistics Canada: CANSIM Table # 228-0059

industry in their quest to promote innovation in the fields of science and technology. Collaboration as an innovation strategy is particularly important in Canada, which is a relatively small player in the global economy and where both the public and private sectors do not have the individual capacity to carry out the range of research and development functions associated with a knowledge economy. Consequently, collaboration between public, private and academic sectors has emerged as an important driver of innovation in the manufacturing sector, especially the automotive industry.

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Collaboration can provide a number of benefits to participating organizations from academia, the private sector, and government. It allows private companies to advance technologies at lower costs and with less inherent risk. Moreover, collaboration provides access to a greater breadth and depth of knowledge and technologies than would normally be possible through internal development.[4] Governments are inherently interested in promoting university-industry partnerships because they are thought to contribute towards the economic growth of a region. Such partnerships allow governments to offload some financial responsibilities and risks to the private sector and hence can be viewed as a cost-saving or cost-sharing strategy.[5] For universities the benefits include additional public and private funding, and increasingly, licensing and patenting income as a result of technology transfer activities. University-industry alliances also allow universities to gain exposure and future employment for their graduate students. Private sector companies also stand to gain from these highly qualified individuals. However, these benefits depend on the effectiveness of a collaboration or partnership, which in turn depends on a number of factors.

Over the recent decades, academics and policy analysts have given significant attention to collaboration and partnerships between academia, government, and private sector organizations that promote innovation, technology transfer, and commercialization. Social scientists have put forth various theoretical and empirical models to understand the dynamics of such collaborations. One such model, developed by Loet Leydesdorff and Henry Etzkowitz, is the Triple Helix Model which attempts to theorize the sociological foundations of institutional evolution resulting from interactions between academia, government and private sector organizations. The model envisions a system of dynamic interaction between the three institutional spheres analogous to DNA, except with a third helix. The Triple Helix presents different possible resolutions among the institutional spheres of university, industry, and government that help generate alternative strategies for economic growth and social transformations.[6] Other scholars have taken a more inductive approach in an attempt to develop a list of factors that are necessary for the successful development and functioning of technology transfers and commercialization collaborations. Some of the factors that are commonly discussed in the literature as critical to the effective functioning and performance of collaborations include: commonality of goals and motivations, communications, entrepreneurial scientists and high quality personnel, organizational cultures, geographic proximity, and project management and leadership.[7]

In order to better understand the functioning and the underlying dynamics of such collaborations between industry, academia, and the public sector, we have undertaken a case-study of one such partnership in the Canadian automotive sector. This particular collaborative effort, known as the Connected Vehicle Technology

4. Tina Barnes, Ian Pashby and Anne Gibbons, "Effective University-Industry Interaction: A Multi-case Evaluation of Collaborative R&D Projects," *European Management Journal* 20, no. 3 (2002): 272
5. Henry Etzkowitz and Loet Leydesdorff, "The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university-industry-government relations," *Research Policy* 29 (2000): 109-123.
6. Etzkowitz, "The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university-industry-government relations," 111.
7. Barnes et al. (2002) and Santoro and Gopalakrishnan (2001) provide in-depth discussion on commonality of goals and motivations; for notes on communication, see Harmon et al. (2002); entrepreneurial scientists and high quality personnel, see Zucker et al. (2002); organizational cultures, see Knoben and Oerlemans (2006); geographic proximity, see Lindelof and Lofsten (2004) and Porter (1998); and project management and leadership, see Barnes et al. (2002) and Tidd et al. (2001).

Showcase (commonly referred to as the Connected Car project), has been primarily initiated by automotive industry stakeholders, including the Automotive Parts Manufacturers' Association (APMA), Toyota Motor Manufacturing Canada Inc., and a number of small, medium and large enterprises, in association with the University of Waterloo and government funding agencies at the federal and provincial levels. In this study we examine the key drivers of this successful collaboration and the factors that have facilitated or hindered its performance. The aim of this report is to develop a better understanding of these factors and to provide a best practices document that can be consulted by the stakeholders of this project going forward.

Following a case-study methodology, we have carried out key-informant interviews with 14 individuals who have been associated with the Connected Car project. These individuals belong to different industry organizations, the APMA, and the University of Waterloo. We have also consulted a number of key documents including budgeting and marketing plans, project timelines, and media reports pertaining to this project. Consequently, our analysis is based on a holistic understanding of this project. We primarily rely on the Triple Helix Model and postulate from a number of academic studies on technology transfer partnerships to establish the theoretical framework for the analysis of our findings.

This report is divided into four sections. Section I discusses the ideas behind this project, how the project was envisioned and the goals of this collaboration, as outlined in the key documents as well as established during the interviews. Section II provides a summary of how the project's origins, the process that was undertaken to choose the technology companies, and the role of the executive steering committee in managing the project. Section III, which is the crux of our report, presents the key findings from the interviews pertaining to lessons learned and best practices in this project. Section IV presents an analysis of our findings and their policy implications in the context of the automotive sector in Ontario and Canada. Section V sums up the discussion and offers concluding remarks.

I. Project Goals and Context

The Connected Vehicle Technology Showcase (CVTS), or the Connected Car project, was the brainchild of the APMA and was undertaken to advance a number of goals. The primary objective of the project was to create a connected car demonstration vehicle featuring Canadian-made technologies that promotes Canadian capabilities directly to original equipment manufacturers (OEMs) for the purpose of increasing new business opportunities, commercializing Canadian technological innovations, and creating industry employment.[8] It is expected that such a demonstration vehicle will allow the companies involved in the project to increase the awareness of Canadian capabilities, create networking opportunities, and cultivate a cluster of connected vehicle technology companies in Canada to support future technology development and continued evolution towards the autonomous car.[9] At a time when the connected car is expected to represent the next wave of automotive innovation, this demonstration project offers the possibility for establishing Canadian firms as leaders in this field.

Industry partners associated with this project realized that Canadian companies have very strong technical capabilities and potential in the information technology and

8. Joseph McCabe, "The Connected Car: The Changing Face of the Automotive Experience," *APMA's Lead, Reach and Connect*, Summer/Fall 2014, 16.
9. Earl Hughson and Sam Alesio, "Connected Vehicle Demonstrator Kick off meeting," Presentation delivered at the APMA Connected Vehicle Working Group Meeting, November 4, 2013.

electronics sectors that can be utilized in the automotive industry as well. While Ontario's automotive-related sector has historically focused on plastics and metals, there is significant growth going in electrical and electronic equipment. At the same time, there are not many Canadian electrical and electronic equipment and information technology companies that have been able to take advantage of this growth in the automotive sector. Consequently, there is a concern that while the automotive industry is rapidly changing, Canadian and Ontario businesses linked to the automotive sector have not kept up with this changing environment. Therefore, one of the key goals of this project is to "promote Canadian innovation" by developing a "Canadian story" about technological integration achieved through successful collaboration between universities, private enterprise, and governments. Project managers and leaders expressed a "sense of urgency" as a key motivator for this project. One respondent highlighted that "if we don't get the Ontario companies in front of the decision makers, it's going to start somewhere else really quick and we will end up with nothing. The whole role of this project [, therefore,] is to expand the number of successful companies we have in the automotive area and get Canada on board with this opportunity with connected vehicles."

One of the key goals of this project is to "promote Canadian innovation" by developing a "Canadian story" about technological integration achieved through successful collaboration between universities, private enterprise, and governments.

The second goal of the project is to create jobs in Canada. The underlying strategy to achieve this goal is to provide a platform for the small and emerging technological innovative companies to market and commercialize their products. Success in this initiative could increase commercial opportunities for these companies, therefore allowing them to hire additional people. All of the key respondents highlighted this as a key goal of this project. Respondents pointed out that while Canada has a very strong pure and applied research focus, there has not been much success in the way of "[converting] that research into business." Therefore, as another respondent pointed out, the industry's intention of this project

> "was not to do [research], because there is already a lot of hundreds of millions of dollars being spent in the U.S. on research and standards that will be mandated into vehicles eventually. We see the opportunity to build business and jobs in Canada as focusing on near term innovation, on getting innovative products and services using technology at hand, to the OEMs and on the road. Our goal is to create jobs in the industry which will improve the economy; it is not to foster research."

The project was also designed to improve training of students. Ross McKenzie, Director of WatCar at University of Waterloo, noted that the project allowed them to "train highly qualified personnel in the form of graduate students" in connected vehicle technology, "introducing new technologies into an existing vehicle, enhancing onboard technologies on an existing vehicle, and then integrating all of those." These training opportunities are critically important to the sustainability of experimentation with connected car technologies, but also to laying the groundwork for developing the type of labour force needed to expand this industry.

Getting access to the OEMs was one of the major challenges identified in the interviews. The CVWG realized that many of the small start-up companies in Canada are not able to get access to OEMs such as Ford and GM. When these companies are able to get that access, the OEMs are not interested in dealing with these companies on the basis of PowerPoint presentations of their technologies. Rather they want to be able to see a working demonstration of the technology integrated in an actual vehicle. According to one respondent, "it gives [the technology] a lot of credibility" when the OEMs are able to see it working along with other technologies in an actual

vehicle. This project was therefore set up with the spirit to "help small and medium sized companies" and "to provide access to the executive levels to the companies that typically couldn't get those meetings." Steve Rodgers, then president of the APMA, aptly described this objective:

> "in effect, what we are basically saying is [that] all we can do is open the door, create the introductions, create the opportunity....You then have to meet the right people and you then have to sell your technology."

To summarize, the Connected Car project was established to comprehensively integrate automotive-related technologies on an actual vehicle that can serve as the demonstrative platform for the partnering companies to showcase their functional prototypes to the large OEMs and tier 1 suppliers. The driving goals of the project were promotion of Canada's technological and innovative capabilities, economic growth through job creation in the innovative sectors, and to train highly qualified personnel.[10]

Collaboration is the underlying strategy that defines this project. This project therefore demonstrates the understanding among Canadian industry leaders that collaboration between industry, academia and government is necessary to capture and promote the innovative potential of Canadian businesses, to integrate technologically complex products, and to work towards economic growth.[11] The project envisions a holistic strategy to innovation, marketing and commercialization of automotive-related technologies in Canada.

II. Project Process[12]

The Connected Car project was envisioned by members of the APMA. Past-President of the APMA, Steve Rodgers, and members of APMA board of directors, specifically Earl Hughson (MIS) and Sam Alesio (Tyco Electrical – TE), were instrumental in initiating this project.

Early conversations about the connected car started in 2010 and a Connected Vehicle working group (CVWG) was established in 2011 by Sam Alesio. Earl Hughson was chosen as the chairperson of this committee. The committee had a mandate to reach out to find Canadian Connected vehicle companies and technologies; identify SMEs not traditionally associated with the automotive industry; foster collaboration and alliances; and leverage government support in order to build a cluster of competency in Canada for these technologies that would lead to economic and job growth.

The working group reached out to the industry and announced its intentions to develop the connected vehicle with novel infotainment, safety, and connected technologies that would be functionally integrated into a vehicle. The committee, after initial consultations with industry groups and members of the APMA, invited applications from companies that had relevant technologies in electronics, telematics, safety and sensory products relevant to the connected car concept. The committee specifically ensured that they reached out to smaller, start-up companies, mostly from outside the automotive industry, in an attempt to assist these companies to enter the automotive field, in addition to the more traditional automotive suppliers.

10. McCabe, "The Connected Car: The Changing Face of the Automotive Experience," 18.
11. Earl Hughson and Sam Alesio, "Connected Vehicle Demonstrator Kick off meeting," Presentation delivered at the APMA Connected Vehicle Working Group Meeting, November 4, 2013.
12. Information on project process was primarily gathered through interviews with Steve Rodgers (Past-President of the APMA) and Earl Hughson and Sam Alesio (members of board of directors of the APMA) and review of documents concerning the Connected Car Project.

A set of criteria were established to judge whether a company's application to join the project would be accepted. These included: direct relevance/application of the technology to the connected vehicle concept; technology had to be ready for production stage; and the company had to invest $5,000 in cash to join the project. The working group met with every company that had shown its interest in becoming part of the project and evaluated them. According to Steve Rodgers, "at that time there was still significant doubt. There was fear that so many technologies cannot be integrated."

The working group simultaneously reached out to government funding agencies and OEMs in order to secure funding and a 'test' vehicle that could be used to integrate and interface the technologies. While most of the funding agencies turned down initial requests for funds, the committee was successful in obtaining a vehicle (Lexus 350) from Toyota Motor Manufacturing Canada Inc. in 2012.

The University of Waterloo was approached as an academic partner, initially with the expectation that they would lead the integration of technologies. However, that role was later assigned to QNX, a Canadian technology leader in developing operating systems for integrating infotainment systems in vehicles. The University agreed to dedicate two post-doctoral fellows who were knowledgeable in the connected-vehicle field and who had expressed connected vehicles to be their primary area of study. These individuals were placed within the QNX headquarters in Ottawa, Canada. The arrangement, according to the respondents, has advanced the "goal of developing HQP and enabled them to undertake integration and interface of technologies, reverse-engineer the codes, and learn about the functioning of canbus architecture." Moreover, having the university involved allowed the APMA to get access to Ontario Centres of Excellence (OCE), Natural Sciences and Engineering Research Council (NSERC), and other related provincial and federal government funding programs that are specifically designed for academic institutions.

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According to Steve Rodgers and Earl Hughson, who led the selection process, approximately 40 companies expressed interest in the project. However, due to financial constraints and lack of funding from government agencies, the working group selected thirteen companies that ranged from small start-up companies to large multinationals. A brief description of these companies and their technologies is attached in Appendix A.

Once the technologies were selected and a vehicle secured from Toyota Motor Manufacturing Canada Inc., the integration work was undertaken by QNX with the help of the University of Waterloo and Lixar. Participating companies worked closely with these organizations in developing the software and interface strategy for their respective products. Integration of technologies was completed in mid-2014 and the demonstration car was unveiled in June 2014 at the APMA's Annual Conference and Exhibition in Windsor, Ontario.

Since its launch in September, 2014, the APMA has been marketing the technologies in the vehicle by presenting the vehicle to the OEMs and at technology shows around the country in the fall-winter of 2014. The APMA is also planning on undertaking "a phase 2 on the Lexus," by either revising the existing technologies or by adding new technologies to the interface. It is expected by the project organizers and partners that these next steps, if done well, will lead to better opportunities for the companies to showcase their technologies to the OEMs, secure business orders, and result in growth of jobs in Ontario and Canada.

a. Strengths and Benefits of the Connected Car Project

Project organizers and partners believe that this particular collaboration between industry, government and academia has been very successful. The project has been foundational in bringing individuals together from different organizational streams, providing them networking and further partnership opportunities with OEMs, Tier 1 suppliers and peers. It has also been successful in gaining OEMs attention. According to Sam Alesio, the founder of CVWG and a member of APMA board of directors, "all the OEMs have been very positive."

What made this project unique was that it allowed a group of diverse Canadian companies with different but complimentary technologies to come together under the umbrella of the APMA and "unite with a forward looking-enough vision to see the benefits of a vehicle with a cross-section of technologies on it.

Based on the success of this project, Justin Moon from Lixar suggested that

> "Programs like this and this program are so important to the technology community in Canada that there needs to be more….This level of collaboration has to exist, especially in auto. We need to show to the global community that Canada is a technology hub for everything that is auto. Whether it is anything traditional from the APMA's perspective, from manufacturing and parts side of things, all the way to software services and how does it relate to in-vehicle experience…These kinds of things have to happen more often."

According to other partners, what made this project unique was that it allowed a group of diverse Canadian companies with different but complimentary technologies to come together under the umbrella of the APMA and "unite with a forward looking-enough vision to see the benefits of a vehicle with a cross-section of technologies on it." Working with companies of different size and with different technological focus has been termed by the industry partners as a "very interesting experience" and "a unique aspect" of this project. For example, Bill Burger, Director of Automotive and OEM sales at ACS Inc., commented that

> "Often times we don't have projects that encompass that type of group of people. And then working with these group members to integrate our products with their system helped us to know of new features, ways that were probably different than how we would have gone about them ourselves. And I think that's a great opportunity when you have people from different fields, different products, all sitting around, talking about each other's products. And how we can make them a better product. So I think that's probably the most unique aspect of this project."

Similarly, Rob Colja, Director of Engineering and Program Management at Leggett and Platt Inc., noted that in bringing together many Canadian companies that may not have come together beforehand, the project has enabled "some cross-migration, cross-sharing or cross-breeding of products and ideas that had potential to expand."

Participants unanimously agreed that the collaboration between the industry partners has been "fantastic" and "has exceeded all expectations." The broader collaborative activity has led to the recognition of further specific collaborative opportunities between two to three companies whose technologies perform complimentary functions in the connected vehicle. For example, Rob Colja pointed out that

> "in our particular case, we ended up working with two of the other companies that were involved in the project and we got to know those companies because of the project. And that has led off into some further research on parts, to see how we go about integrating those technologies into ours to create a higher value product to the customer."

These specific partnership opportunities, according to Earl Hughson, have been made possible through this project which has brought these companies together "that would have never met each other." Justin Moon further observed that the project has not only introduced the companies and individuals to each other, but it has allowed them to build relationships and friendships that will extend beyond this project and will benefit everyone involved.

Beyond intra-group collaboration, the project has also provided significant networking opportunities. Steve Rodgers noted that "they [the companies] all recognize that being on a vehicle, getting this type of publicity, is not something that they were going to be able to do on their own." The project, according to the organizers, has gotten considerable positive attention from the OEMs and specifically governments since the completion of the demonstration vehicle. While the marketing and demonstration tours are in their early stages, the participants agreed that the benefits from networking have "started to materialize" and will continue in the future.

Tim Newman, the founder of the start-up company BRAKERS, noted that the project has allowed the company to "get an audience with the automaker" which would have otherwise been "very difficult." Bill Burger contended that the project has "raised [the] company profile within the automotive industry." Overall, the respondents agreed that the project has been instrumental in providing the networking opportunities and raising the public profile of the partner organizations.

III. Best Practices and Lessons Learned

Through the course of interviews, respondents identified a number of best practices and lessons learned that provide useful input for collaborative projects of this nature in the future. These are related to project management and leadership, communications, government funding practices, and organizational differences. In he following sections, we delve into each of these in greater depth.

a) Role of QNX Software and Toyota Motor Manufacturing Canada Inc.

Individual respondents highlighted the role of a number of organizations and individuals who were instrumental in leading this particular project. QNX Software Systems and Toyota Motor Manufacturing Canada Inc. have been particularly appreciated by the partners for their respective roles in integrating the technologies, providing the vehicle and providing strategic leadership to the overall project respectively.

QNX Software Systems, a Canadian Software Company based in Ottawa which specializes in providing operating software for numerous technological platforms, has been instrumental in providing the engineering capabilities required to integrate all the technologies in the showcase vehicle. Moreover, having the technologies work on a QNX operating system, a globally recognized secure and innovative platform, provided credibility to the technologies being integrated into the vehicle as part of this project.

QNX provided the industrial design for the vehicle as well as the assembling of the actual technologies and the wiring and integration of technologies in the vehicle. According to one respondent, "[QNX] was really the glue that brought all these

partners together and allowed them to interact with each other in a real production-like environment." Respondents unanimously agreed that QNX played a vital role in ensuring that all technologies were seamlessly integrated and function well together and with other aspects of the vehicle.

Earl Hughson highlighted the significance of QNX's contributions to the project as follows:

> "We are lucky to have QNX here because they are the only company around that could do that level of integration because they have an operating system that can integrate a whole variety of technologies. So they were really the backbone of this project."

Bill Burger echoed similar views:

> "From the implementation point of view, I think we were *extremely* [emphasis added] fortunate to have QNX because they put in a massive amount of time, massive amount of expertise and funding along with resources in project management. I think if it were not for their contribution to this project, it would not have been completed in the timeframe that we had and with the quality that the product has. Really the success is purely due to QNX."

Toyota Motor Manufacturing Canada Inc., which provided the Lexus 350 vehicle to this project, has also been acknowledged in high regard for supporting the project. In this regard, contributions of Ray Tanguay and Greig Mordue, Chairman and General Manager of Toyota Motor Manufacturing Canada Inc., respectively, were highlighted by the respondents for their commitment towards supporting the Ontario automotive industry in undertaking such projects. Respondents further acknowledged that without the vehicle, the project would not have gotten underway and "it would just be a group of technologies." Bob Burrows noted in particular that:

> "getting the vehicle was huge. That gave the whole project focus and traction. It also meant that the biggest four companies were committed because they would never risk their business with Toyota….It brought big automotive supply companies, that really didn't need this, on board, because they wanted to be seen as supporting Canada. They wanted to be seen by Toyota as supporting Canada because they have developed that relationship."

b) Project Management

Managing complex horizontal projects that have organizations and individuals from different institutional backgrounds with unique sets of expertise and skills and different levels of resources is a significant challenge. Collaborative projects like the Connected Car require strong project management and central leadership, either by an individual or an entire organization. Literature on technology transfer partnerships highlights the importance of project management for the effectiveness of such partnerships. Varying degrees of emphasis are placed on different aspects of project management; however three aspects stand out. These include: clearly defined objectives and agreement on those objectives by all participants, leadership, and effective communication.[13] The literature also highlights the importance of project management and a liaison that can provide guidance to the collaborators and monitor the progress of the overall project. In the next sections, we discuss the key aspects of project management vis-à-vis the Connected Car Project. A discussion of these aspects

13. Tina Barnes, Ian Pashby and Anne Gibbons, "Effective University-Industry Interaction: A Multi-case Evaluation of Collaborative R&D," European Management Journal 20, no. 3 (2002): 276-278

highlights the challenges of managing complex collaborative projects and establishes the best practices and recommendations for improving the overall management of the Connect Car Project going forward.

i. Leadership:

Leadership is an important aspect of projects, collaborative or otherwise. It becomes even more important in horizontal collaborations, where partners belong to different organizations and contribute different resources and skill sets towards the end goal. In such partnerships, each of the partners may have their own agendas and motivations, which may or may not be aligned with the broader goals of the project. It, therefore, becomes critical for one individual or organization to provide necessary guidance, manage the conflicting goals, and provide organizational resources for effective functioning of the partnership.

In the case of the Connected Car project, respondents unanimously agreed and stressed the importance of project management and leadership, which was provided by the APMA. Respondents agreed that this project was the "brainchild" of the association, which played a role in coordinating and getting companies together. One respondent noted that "if it wasn't for the APMA, being an association where all the various automotive suppliers could come together, this kind of an idea would be very difficult to get coordinated. They enabled the forum for discussion and planning of the basic idea."

While the respondents unanimously agreed to the importance of project management and leadership and the role played by the APMA and its board of directors, most of them suggested that there were some shortcomings in both aspects in this particular project. Respondents felt that there was a "lack of leadership structure" and "no clear ownership of the project" despite claims by a number of respondents that this was "an entirely industry-led and owned project." These concerns were in line with findings from the broader empirical literature and primarily highlighted the complexity of managing collaborative projects that are horizontal in nature and which require project managers to achieve a delicate balance between recognizing the capabilities, resources and motivations of individuals and organizations while striving to move toward a common goal for the overall project. Moreover, respondents also complained that the project suffered due to lack of concrete guiding documents including budget, marketing plans and unclear timelines. These concerns also indirectly relate to problems in attaining timely funding from government agencies and differences in organizational cultures. We tackle both these issues in the following sections.

Respondents also pointed out that the APMA's president and vice-president, who were primarily responsible for putting everything together and providing the overall direction to the project, "already had their plates full." The project, as one respondent noted, needed someone within the APMA who, while reporting to the senior APMA management, could act as the lead and the central liaison. However, this view was not shared by other respondents. The APMA executive, while acknowledging the challenges in the management of such "complex projects," highlighted the resource constraints of the APMA as a significant underpinning cause of these challenges. The executive committee, including Steve Rodgers, Earl Hughson and Sam Alesio, noted that all the executive committee members volunteered their time and resources for this project. The APMA is a not-for-profit organization, which largely depends on the membership dues for its operations. Earl Hughson, further highlighting the resource constraints of the APMA, suggested that "the APMA doesn't even have a parking spot.

It's an office with a small staff in a tower." These resource constraints, according to the respondents, constrained the APMA's capacity to manage the project.

Despite the gaps in project management, respondents had a positive impression of the APMA and agreed that the APMA has played a "very positive role" in initiating and managing the Connected Car project. One respondent noted that "the APMA is currently the only available forum for the companies to sit together and talk about these things and come up with proposals and ideas on how do we do better to present companies and products to the OEMs. So I think the lessons learned and how do we do things better, [also] need to be taken back through that forum." Respondents also noted that much of the project management issues could be dealt with through improved communication, an issue that we turn to in the following sections.

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ii. Common Goal:

Sharing a common vision and goals is a very important first step in successful partnerships. It allows the partners to set aside their personal or organizational differences, develop a community of interest and engage in a meaningful exchange of ideas and critiques. Empirical literature identifies a number of cases in technology transfer partnerships where lack of a well-defined goal and/or absence of agreement over a common goal by all the collaborators leads to ineffective or failed collaborations.[14] Having well-defined and realistic goals with buy-in from all the partners is, therefore, an essential prerequisite for successful and effective collaboration.

In the case of the Connected Car project, the shared vision of the partners towards the goals of the project was an important facilitating factor in the project's success. Respondents agreed that all the partners shared a common vision and agreed with the goals of the project, namely job creation, raising Ontario and Canada's innovation profile and creating avenues for commercialization of innovative automotive-related technologies. As one respondent noted,

> "[the] industry came together very well with a common goal over the thousand individual goals for companies. And that persistence allowed us to make things happen."

Another respondent suggested that

> "the focus on getting jobs in Canada and building an Ontario-based Centre of Excellence for Connected Vehicle was common in all industry partners and allowed for things to get done in-spite of 'a lot of mud on the road'."

Justin Moon, who has been at the helm of creating an interface design for integrating all the technologies together, suggested that

> "Everybody buying into a single design philosophy helps…. So there was a common goal and common ground and everybody worked to achieve that."

Agreement on common goal(s) was presumably achieved as a result of having well-defined goal(s) in the first place, which is evidence of good planning in the initial phases of the project by the executive team of APMA.

iii. Communications:

If collaboration between multiple partners is critical for future technological

14. Tina Barnes, Ian Pashby and Anne Gibbons, "Effective University-Industry Interaction: A Multi-case Evaluation of Collaborative R&D," European Management Journal 20, no.3 (2002): 274.

development and innovation, communication between the different firms and across the public, private and university partners is a critical factor in facilitating coordination across multiple partners and deepening collaboration. Theoretical frameworks and empirical studies on innovation and collaboration highlight the importance of communication in the establishment and effective functioning of technology transfer and commercialization partnerships. Effective communications across institutional domains underpin the functioning of the Triple Helix Model of innovation, whereby strategic communication opens new windows of opportunity by combining differing institutional perspectives. In the Triple Helix framework, communication is therefore integral to effective interaction between collaborators and adaptation of institutional dynamics.[15] Simply put, effective communication between partnering organizations can help develop trust, overcome differences in organizational cultures, generate new ideas and develop understanding and consensus around the goals of the collaboration as well as the expectations from each of the partnering organization.[16]

Effective communication between partnering organizations can help develop trust, overcome differences in organizational cultures, generate new ideas and develop understanding and consensus around the goals of the collaboration.

While most existing studies focus on the transfer of technologies that originate in university or public sector laboratories, effective communication is also integral to technology transfer partnerships initiated by industry-based technologies as in the case of the Connected Car project. Respondents from the project were almost unanimous in their view that communications between partners, especially between industry and academic partners, which is an essential element in the smooth functioning of such collaborations, was "dysfunctional" and marked it as a priority area of improvement going forward. Many respondents argued that expectations, budget plans and timelines were not clearly communicated, which resulted in uncertainty among the partners. Bill Burger of ACS noted that "as with so many projects, communications is really critical in achieving the maximum benefits in a certain amount of time. And I feel that there was a lack of communication." Similar views were shared by another respondent who suggested that "the biggest lesson that should be learnt is communication. So that collaborators can have a true understanding of the expectations. If there is no communication, then that's when 'side conversations' happen and that's when misinformation happens."

One respondent noted:

> "I think you have to have those open lines of communication...if you want one improvement points for this program, [that would be] *communication* [emphasis added]. It is probably the biggest detractor. Communicating between the APMA, the university, the government and the member companies…there is improvement that can be done there."

Project leaders, while acknowledging the shortcomings in communications, suggested that efforts are being made to improve communication between the APMA, customers, member companies, and the university. Earl Hughson argued that "there is a lot happening and we can do better at communication so that we are better coordinated."

To the extent that partners communicated with each other during the integration phase, it allowed the technical team, led by QNX, to develop a coherent integration strategy. In-person and teleconference meetings at this stage helped the partners understand the "integration philosophy" and follow the guidelines provided by QNX and Lixar with regards to system design and software development.

15. Loet Leydesdorff and Martin Meyer, "The Triple Helix of university-industry-government relations," Scientometrics 58, no.2 (2003): 191.
16. Brian Harmon, Alexander Ardishvili, Richard Cardozo, Tait Elder, John Leuthold, John Parshall, Michael Raghian and Donald Smith, "Mapping the university technology transfer process," Journal of Business Venturing 12:

Respondents suggested that going forward there ought to be more group meetings, whereby future plans should be communicated clearly to the entire group and details about funding, marketing and further development strategies and timelines along with partners' responsibilities should be "transparently and openly discussed among all the partners." One strategy suggested by a respondent was to "conduct regularly scheduled conference calls and to follow up those conference calls with meeting minutes which can then be converted into task lists and serve as an accountability mechanism." This aspect of communication dovetails with expressed concerns over project management which it was argued required formalization of documentation regarding financial plans, timelines, responsibilities of the partners and resource distribution within the group. As with project management, good communication requires adequate resources, something which the project laboured to provide.

Good communication could also play a role in ensuring that stakeholders from different sectors develop an understanding of each other's financial, organizational and human resource constraints and cultures, thus reducing the tensions that were expressed between University partners and private firms.

c) Differences in Organizational/Institutional Cultures

The literature on technology transfer collaborations often points to the impediments caused by differing cultures of participating organizations.[17] These differences arise as a result of different motives and priorities, perspectives, ways of doing things, and ideological/cultural beliefs and held by participants in academia, and public and private organizations. The private sector is governed by a set of motivations and perspectives about the nature of technology and knowledge that is different from those governing the academia, for example. Private firms are mostly motivated by pursuit of profits and competitive advantage over commercial rivals; academics have traditionally been motivated by new discoveries and the generation and public dissemination of knowledge.[18] Often referred to as the 'Two Cultures Problem', the normative and attitudinal differences separating universities from industry are seen by many to be inexorable and present often surmountable barriers to close cooperation between the two sectors.[19] The conceptual differences can also give rise to differences in operational standards and timelines, which can ultimately hinder the progress of a collaborative project. Lack of effective communication, as highlighted in the previous section, further impedes any efforts on part of the collaborators to understand each other's organizational culture and to develop common goals and achieve mutually beneficial outcomes.[20]

Differences in organizational cultures, especially across the institutional boundaries of private companies and the University, were highlighted in interviews as a barrier in the execution of the Connected Car project. Views on this issue were not shared equally by all respondents. Some respondents, particularly from the private sector, noted that there are "huge differences in attitude, in culture, in agenda [and] timeframes" as well as "accountability structures" across the different organizations. One industry representative noted that:

> "…there is a big difference between an automotive company and a university. The precision of program management and timing in the automotive industry is extreme and it isn't at all in the university. So that has been a cultural struggle, I think, for the whole group."

17. Examples of studies on the impact of organizational cultural differences on effective collaboration performance include Knoben and Oerlemans (2006), Barnes et al. (2002), Lee (1996) and Bonaccorsi and Piccaluga (1994).
18. Tina Barnes, Ian Pashby and Anne Gibbons, "Effective University-Industry Interaction: A Multi-case Evaluation of Collaborative R&D Project, European Management Journal 20, no. 3 (2002):
19. Young Lee, "Technology Transfer and the Research University: A Search for the Boundaries of University-Industry Collaboration," Research Policy 25 (1996): 856.
20. Barnes, "Effective University-Industry Interaction: A Multi-case Evaluation of Collaborative R&D Project," 278.

Respondents also noted that the two institutional spheres usually have "different and varying goals," that is, the private sector is driven by the profit motive whereas the university has a research and education focus. Ultimately, it was noted, both sectors try to leverage their strengths, which sometimes creates conflict and misunderstandings. Working with government funding agencies added yet another layer of complexity to the functioning and management of the collaborative endeavour. Ross McKenzie, Director of WatCar at University of Waterloo, in acknowledging these challenges argued that the timeframes of industry, university and funding partners are mostly divergent. In this particular project, these differences were further exacerbated by coordination challenges that arose because the project managers had to coordinate between 13 companies, a team of six professors and researchers and multiple government funding agencies.

Collaborations across the university-industry-government frontier are 'good learning opportunities' and 'not only are they worthwhile, but they are absolutely necessary.

Furthermore, in regards to this particular project, respondents noted that the University of Waterloo was asked to join the project for their potential ability to integrate the technologies and leverage the government funding programs that could only be accessed by academic institutions. However, neither of these goals was met fully. While graduate students and post-doctoral fellows from the university assisted in the technology integration phase, the overall integration process, for reasons not specified by the partners, had to be undertaken by QNX. This, according to the respondents, created "logistical challenges" as well as "constraints on time and human resources," since many of the companies had to station their personnel at QNX headquarters in Ottawa.

The other limitation, discussed in the previous section, was the University's lack of success in generating funds for the project through government funding programs. As explained by Steve Rodgers, one of the primary reasons for including the University of Waterloo in the project was to leverage various pools of government funding at Ontario Centres of Excellence (OCE), Ontario Research Fund (ORF), ENGAGE and National Science and Engineering Research Council (NSERC), which are only available for academic-based programs. However, most of these funds associated with these programs had not come through at the time interviews were conducted. To the extent that the university received any funding for its graduate and post-doctoral students, these funds were not eligible for transfer to industry partners, although these students did work closely with industry partners at QNX. Some respondents thought that these financial problems were further exacerbated due to lack of communication by the university on utilization of these funds in relation to the overall project. This harkens back to an earlier discussion of the need for clear communication between project collaborators on the project budget.

While some respondents stressed the problematic aspects of collaboration between industry, academia and government including differences in organizational cultures and attitudes, other respondents were more positive in their views towards the inter-institutional dynamics of the collaboration. These respondents pointed out that collaborations across the university-industry-government frontier are 'good learning opportunities' and 'not only are they worthwhile, but they are absolutely necessary.' Respondents acknowledged that there are 'always going to be differences in politics' in any collaboration involving industry, academia and government. However, these differences can be attributed to the "bureaucratic set up of each organization." One respondent noted that while there were challenges

in regards to the industry-university-government interaction, the challenges

> "weren't all that different from dealing with just a large bureaucratic company. We can compare a university to that [large bureaucratic company]. On the other hand, the students that the university have working on the project are very bright and very good and they were not very different than employees from other companies."

Another industry partner noted that their company has successfully collaborated with various universities across southern Ontario including University of Waterloo and the Connected Car project was yet another successful collaboration of such kind.

In regards to overcoming these challenges going forward, it was suggested that repeated interactions across institutional frontiers can help partners develop better and realistic expectations about each other's capabilities and resources. One respondent suggested that "each of the segments, whether they are university, government, or small and large business, has varying degrees of resources and ability to contribute to these types of initiatives. The people assigned for the leadership of these kinds of projects need to show an appreciation of what [, and how fast,] the different segments can contribute versus the idealized requirements." Furthermore, it was argued that agreement on a common goal and "patient persistence" can help the partners overcome many of these organizational cultural differences.

Earl Hughson noted that "right now we don't even have enough money to ship it [the demonstration vehicle] to customers' locations. We have spent all this money, we are getting a whole lot of interest in it, and there is no money to take it to a customer and demonstrate it."

d) Funding & Resource Allocation[21]

One of the key challenges in the functioning of this partnership, as highlighted by the respondents, was lack of funding from government agencies. Respondents, specifically the executive committee members, pointed out that all the major goals of the project have been met except the funding. This shortfall could potentially hamper the future progress of the project. They agreed that without government funding programs, progress would be difficult, because "the companies' individual commitment combined with the university's financial contribution wouldn't be enough." Earl Hughson noted that "right now we don't even have enough money to ship it [the demonstration vehicle] to customers' locations. We have spent all this money, we are getting a whole lot of interest in it, and there is no money to take it to a customer and demonstrate it." Given the centrality of funding to the functioning of projects like this, it is imperative that we take a deeper look into the funding requirements and challenges that have been experienced in the Connected Car project.

Steve Rodgers pointed out that the project has not received any substantial funding from the federal and provincial programs that are currently in place. The total amount of funding that the APMA has received for marketing (at the time of the interview) is $7,500 from the Export Development Corporation (EDC) in exchange for putting an EDC logo on the demonstration vehicle.

It was pointed out during the interviews that the initial conversations with the government funding agencies, especially the OCE, appeared "promising." All the funding agencies received the idea of an integrated connected car "very positively" and assured generous funding for the project. According to Steve Rodgers, OCE had verbally committed to provide $800,000 funding for the overall estimated costs of approximately $975,000. However, the project had received only $25,000 of the promised $800,000 in the first five months. A total of thirteen applications were submitted by the APMA under the OCE ENGAGE program; however all of them were

21. Information regarding financial aspects of the Connected Car project was primarily provided by Steve Rodgers.

turned down. At the time of the interview, Steve Rodgers reported that "of the $800,000 we expected to get, all we have got is $120,000. Then there was funding that went to the companies: two got IRAP funding for $40,000." As a result of this funding shortfall, QNX effectively donated approximately $500,000 towards the integration costs of the vehicle. Moreover, Toyota Motor Manufacturing Canada Inc. has donated $55,000 in-kind, through its donation of the Lexus to the project. The University of Waterloo is expected to contribute approximately $300,000-$350,000 that the project managers expect it will be successful in securing from the funding agencies. However, according to Steve Rodgers and Earl Hughson, the most significant impact of shortfall in funds will be on the marketing strategy and future collaborations. Steve Rodgers contended that while the executive team hopes to receive more funding in the future, the marketing budget is an immediate concern. As mentioned previously, the APMA had received only $7,500 out of a proposed marketing budget of approximately $70,000. Consequently, the marketing efforts may have to be pulled back for the Fall 2014. According to Steve Rodgers, a number of technology showcase days and other marketing commitments may be cancelled due to lack of funds. Respondents also noted that lack of funding and delays in the delivery of funding promises also had a negative impact on the development of a clear budget guideline for the overall project. One respondent suggested that if there was a yearly budget provided by the government, the APMA could develop its own budget document that could in turn allow the partners to build a roadmap for the vehicle. Lack of funding is, therefore, a major impediment in the growth opportunities for the Connected Car project.

OCE [representatives] admitted [that] 'this is what we think OCE should be doing, but when we actually look at our rules and regulations, it isn't. What we think we should be doing and the way we have set our rules, doesn't really work'.

Respondents pointed out that one of the biggest challenges in securing funds from government agencies is the rigidity of the funding programs. For example, Steve Rodgers highlighted that despite initial verbal commitments, "OCE [representatives] admitted [that] 'this is what we think OCE should be doing, but when we actually look at our rules and regulations, it isn't. What we think we should be doing and the way we have set our rules, doesn't really work'." Furthermore, respondents highlighted that the funding agencies may not have understood the true intent of the project. One respondent noted that while the project was presented as new technology development and integrating those technologies into the vehicle, the perception among the funding agencies was that it is "just a prototype…this is all marketing."

Other respondents also noted the potential negative impacts that lack of funding may have for small companies. One respondent noted that the financial contributions by the smaller companies account for their "entire marketing budget" and consequently stand to lose significantly if the marketing of the project does not proceed as intended. For example, Tim Newman, the entrepreneur responsible for the one-person start-up company BRAKERS, highlighted the challenges he faced in terms of funding as follows:

> "The biggest trouble I had so far is funding. And no matter when I approach a government agency, I had a discussion about funding. It seems I don't fit into their parameters…At the moment, I haven't had a successful conversation as of yet. Now with that said, I am applying for the OCE grant. This was the NSERC grant. And that's to have the software finalized. Until that happens, I guess I am at a stalemate with the other programs."

Respondents also suggested that the amount of time required to complete the paperwork for the funding grants was underestimated. Consequently, the executive

committee was consumed in "going after different grants and different funding" rather than focusing on the technology roadmap and exploring future development possibilities for the vehicle.

Respondents also highlighted a number of possible reforms and changes to the funding programs. This is discussed in the section on lessons for government policy.

e) Fairness in contributions and benefits

In cross-institutional, multi-organizational partnerships and collaborations, it is expected that all partners 'bring something to the table' or in other words, contribute something towards the achievement of the goals of the partnership. Moreover, the benefits should be fair relative to the contributions. In regards to the Connected Car project, most respondents viewed the contribution-benefit distribution of the project to be relatively fair. Nonetheless, there were some concerns that organizations such as QNX and APMA had to shoulder a much larger share of responsibilities and costs. Respondents specifically noted that QNX undertook the integration at a huge cost and devoted significantly higher human and capital resources relative to other organizations in this project. In regards to the APMA, respondents highlighted the volunteer contributions of the CVWG and the altruistic nature of their efforts. One respondent noted that the "executive team has been putting in tonnes of hours, way more than were anticipated."

Some respondents suggested that the effort required on each partner's part was not evenly distributed. Some partners invested more time and financial resources than others with disproportionately lower returns as compared to others. It was also noted that contributions by companies were not always proportionate to their size. According to one respondent, "some of the bigger companies did [not] do a whole lot; some really stepped up and when they did, they did it in a way [that was] very supportive and encouraging to the smaller companies." Other respondents also suggested that the size of the company did not necessarily dictate their participation level.

Ross McKenzie noted that "some companies had a technology that was still being developed and it was beyond a concept, but not much further than a beta test platform. So there was a lot more effort required on their part to not only make it work out but enhance it as you went on. Other companies were further advanced in the development of their technologies." This asymmetry may explain some of the differences in input/output and benefits accrued from the project. On the whole, respondents felt that the project has benefited all the partners in a relatively fair manner.

f) Lessons for Government Policy

Government support, in various forms but especially funding, is an important enabling factor behind the success of collaborative programs such as the Connected Car project. Individuals from industry groups have, on numerous occasions, stressed and appealed to governments for designing policies and programs that can facilitate the development of collaborative projects. Recently, Ray Tanguay, the President of Toyota Motor Manufacturing Canada Inc. stressed this point in his remarks as keynote speaker at the 2014 APMA Annual Conference and Exhibition held in Windsor, Ontario. Mr. Tanguay urged the governments to mobilize more financial support for the industry to undertake collaborative programs while allowing the industry more flexibility and control over the design and execution of these programs.[22] As noted in the previous

22. Ray Tanguay, CEO of Toyota Motor Manufacturing Canada Inc. made these remarks while delivering the key note lecture at the 2014 APMA Annual Conference & Exhibition on June 4th, 2014 in Windsor, Ontario. The Connected Car was also revealed to the media at this event.

sections, the Connected Car project has experienced significant delays and hurdles in securing funding from government agencies, which has threatened further progress of the project in terms of marketing and development including Phase 2 updates. Respondents specifically noted the inability of governments to support such endeavours results primarily from "rigidly designed programs and policies" into which the mandate and goals of the Connected Car project did not fit easily, if at all.

Respondents noted that government agencies have been quite receptive and supportive of the idea in general; however, they do not provide financial assistance because "the money is allocated to do different things" and "programs don't necessarily fit." One respondent likened the government funding programs vis-à-vis collaborative projects to "trying to put a square peg into a round hole." Earl Hughson noted that OCE even tried really hard to make their program work and "it wasn't easy…because it wasn't a perfect fit for what we wanted to do, but they were determined to assist in some way." Yet there was disconnect between the actual programs and bureaucrats' willingness to assist. Respondents also noted that multiple layers of government bureaucracy and the multiplicity of funding agencies spread across different levels of government (federal and provincial) made funding applications and applying for government support very difficult to navigate.

Respondents also noted that multiple layers of government bureaucracy and the multiplicity of funding agencies spread across different levels of government (federal and provincial) made funding applications and applying for government support very difficult to navigate.

While respondents stressed the need for government agencies to make funds available for a project such as the Connected Car, they also demonstrated pragmatic expectations in relation to accountability and overall economic circumstances. As one respondent noted:

> "I don't know if it's possible to make the programs more flexible in an era where you have justifiable degrees of accountability on how taxpayer dollars are spent. So I think it's unrealistic to say 'oh you have to make it easier, you have to make it faster, you have got to make it less paperwork."

A number of respondents highlighted the importance of establishing connections within the government bureaucracies. Ross McKenzie argued that:

> "what makes the program work, from a public policy level, is people. So if you can get someone within the funding partners who can see the endgame and share the end goal and realize there is merit in the vision and while this isn't necessarily straightforward or something that hasn't been done before, doesn't make it a bad idea....Then you have almost, you have got a collaborative environment from the outset…[However,] if you don't have the people that share that vision within the funding partners, you are not going to realize everything that you would otherwise have set as your objective from the outset."

To take the square peg-round hole analogy further, engagement with the individuals who are responsible for delivering the programs within the funding partners can allow the project leaders to "paint the picture and shape that square peg so it fits in the round hole." Another respondent noted that it is important to "identify funding decision-makers" who can assist the program representatives through the process of "knocking on multiple doors."

Sam Alesio, founder of the CVWG, suggested that utilizing government support is a process and often takes a long time to navigate through myriad layers of bureaucracy and different funding programs. In order to mitigate these challenges,

project managers of collaborative programs such as the Connected Car ought to have a "comprehensive plan" which identifies the "backup funding options" in case primary targets are not met. He further noted that it might also be helpful for the executive committee to actively pursue political advocacy avenues and approach ministers, MPs and MPPS in addition to establishing contacts within the bureaucracies.

Another idea that emerged through the interviews was to create a dedicated position within the program to deal with the funding process, assist with identifying and applying for different funding opportunities and liaise with government agencies. One respondent suggested the presence of an individual in their company who deals with government funding is a best practice. According to this respondent, "this individual has, over time, learnt about the funding process, the different avenues that are available and identified the key individuals within the bureaucracies."

IV. Discussion & Concluding Remarks

There has been an increasing emphasis on collaboration to achieve innovation and economic growth. Collaborations between academia, government and private companies are now considered an important instrument in promoting transfer and commercialization of valuable technologies with economic potential across various sectors. Such collaborative activity gives rise to cross-breeding of knowledge that spans institutional boundaries, leads to new ideas and eventually the evolution of institutions in a direction that is conducive to innovation and economic growth. Collaboration has especially become a valuable tool for the Canadian automotive industry in its quest to promote innovative technologies and foster growth in the wake of increasing global competition and volatile economic environment. The Connected Car project provides an excellent illustration of the benefits of collaboration between industry, government, and academia.

The Connected Car project, under the leadership and guidance of the APMA's executive team as well as QNX and Toyota Motor Manufacturing Canada Inc., brought together 13 disparate industry organizations and University of Waterloo to promote Canadian competencies in automotive related technologies, create jobs and spur economic growth in Canada. The project demonstrates that despite challenging circumstances, such collaborations have the potential to benefit all the participating organizations in different ways while pursuing a broader goal, that is, economic growth and job creation. It also underpins the importance of collaboration to promote innovative prowess of Canadian companies at a global scale and to ensure that the Canadian automotive industry remains competitive in a challenging global economic environment.

Despite a number of hurdles and barriers, the Connected Car project has been declared a successful example of collaboration in the Canadian automotive sector by those who participated in this project. Our interviews suggested that this program has been mostly successful due to:

- the resolve and persistence of all the partners;
- a long-term vision and common goal with the aim to help each other and strengthen the Canadian economy; and
- the leadership of a number of individuals and organizations most notably the APMA, QNX and Toyota Motor Manufacturing Canada Inc.

Nonetheless, a number of issues remain to be resolved which are critical to the functioning of such partnerships, as identified in the broader literature on innovation and technology transfer and commercialization partnerships. The respondents identified the following key areas for future improvements in the program:

- Improved program management as evidenced through:
  - better accountability through formalization of contractual obligations of each of the partners;
  - documentation of the budget;
  - open and regular communication; and
  - equitable distribution of resources
- Developing realistic assumptions about each other's capabilities, strengths and constraints
- Sustainable and timely funding from government agencies

The reader may note that these are not necessarily mutually exclusive issues; rather, improvement in one aspect can potentially lead to improvements in other areas. For instance, better communication can lead to developing realistic assumptions about each other's capabilities and constraints; similarly, removing uncertainty in terms of funding from government agencies can allow the project managers to prepare a comprehensive budget document that can further guide the efforts of the partners. Improvements in some of the areas may undoubtedly be challenging given external factors; however through repeated interactions and 'patience persistence' these challenges can be overcome and the Connected Car project can be developed as a positive precedent for future collaborations and technological innovation within the automotive industry in Canada.

The Connected Car project provides an excellent illustration of the benefits of collaboration between industry, government, and academia.

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APPENDIX A: Profile of participating companies

Alcohol Countermeasure Systems Corp.

Alcohol Countermeasure Systems’ ALCOLOCK L series device ensures that drivers are not under the influence of alcohol prior to ignition. Alcohol Countermeasure Systems (ACS) is leading producer of alcohol interlocks and breath alcohol testers. Originally designed for law enforcement in 1976, the ACS product line has expanded to serve the automotive, industrial, public and personal safety markets. With over 500 employees, ACS produces some of the most accurate and reliable alcohol sensing equipment available in the industry. Corporate headquarters of the company are located in Toronto, Canada with satellite offices in Australia, Europe, Asia and the USA.

An alcohol interlock is a device that keeps a vehicle from starting if the driver has a breath alcohol concentration (BrAC) over a pre-set limit. The alcohol interlock typically consists of a handheld breath alcohol tester and an electronic control unit

(ECU) that is connected to the starting mechanism of any motor vehicle. As a member of the connected vehicle project, ACS has integrated the L Series alcohol interlock handset directly to the vehicle CAN bus over the QNX operating system. Integration into the vehicle removes the requirement of an ALCOLOCK ECU; the prevention of starting the vehicle is now communicated directly from the ALCOLOCK handset to the vehicle's immobilizer, providing significant cost savings. User interface that is typically displayed on the ALCOLOCK handset, such as testing instructions and results, is now presented on the vehicle's instrument cluster. This provides the driver with a more dynamic user interface. Further functionality will include a mobile app that allow the vehicle administrator to access the interlock settings remotely or to disable it when servicing the vehicle or in cases of emergency. The consumers will also be able to view breath alcohol tests with GPS coordinates in real time.

Technological Contribution: Alcohol Countermeasure Systems contributed its ALCOLOCK L series device which ensures that drivers are not under the influence of alcohol prior to ignition.

BRAKERS Early Warning Systems Inc.

BRAKERS technology provides early warning to drivers as first responder vehicles are approaching. BRAKERS Early Warning Systems Inc. is a start-up company located in Belleville, Ontario. BRAKERS has developed an innovative product, designed to inform motorists, in advance, of approaching emergency vehicles or when approaching an emergency situation. This happens from within the confines of their car as an emergency vehicle approaches. Notice will be given based the speed of the emergency vehicle and the type of situation. Example of the messages include: "yield so we can get by", "parked on the shoulder", parked at an accident" or "lanes are closed". BRAKERS is offering the receiving software to automakers at no charge. The company has designed this product so that it can be a standard feature on new vehicles at no cost to automakers and without the need to change or add hardware. It can work with a car that has an internet connection or with a smart phone using its data with the same result. The BRAKERS system interrupts the function of the radio to broadcast a message being transmitted by an emergency vehicle. The BRAKERS transmitter technology does not require any further testing from the FCC or Industry Canada. The software being used for the receiver does not require testing and intellectual property rights for the BRAKERS system have already been granted.

Technological Contribution: BRAKERS technology provided and early warning system that warns the drivers of approaching first responder vehicles.

Intelligent Mechatronic Systems, Inc. (IMS)

Intelligent Mechatronic Systems Inc. (IMS) is a leader in connected car services that enable safer, smarter, and greener transportation. IMS does so by providing driver-centric connected car services with the award-winning DriveSync® platform. These automotive services include the convergence of innovative human machine interfaces (HMI), context-driven machine-to-machine services (M2M) and data intelligence designed to deliver a seamless and high quality driver experience. IMS continuously advances its platform for the benefit of its partners, building on more than 15 years of experience delivering driver-centric services throughout the connected car ecosystem, and a portfolio of more than 145 patents globally. IMS' DriveSync connected car technology has been seamlessly integrated into the Lexus vehicle showcasing a complete, OEM-ready solution that delivers both precise driving behaviour assessments and useful

feedback to improve driver performance. The APMA Lexus vehicle demonstrates IMS technology seamlessly integrated with QNX, while maintaining interoperability with other automotive platform. In the APMA Lexus, vehicle and driver behaviour information is provided through intuitive visualizations using the center console. This visualization, with actionable feedback about driver behaviour, builds on telematics information collected from the vehicle and processed through IMS' contextual behaviour-based analytics engine. IMS' continuous innovation and seamless integration of HMI, M2M and data intelligence ensures ongoing value is delivered in-car to the driver and out-of-car to the parent, automotive manufacturer, dealer, service center, insurance carrier, and other partners in the connected car system.

Technological Contribution: Intelligent Mechatronic Systems (IMS) provides driver and vehicle statistics and analysis through the DriveSync Modular telematics platform.

Leggett & Platt Automotive Group

Leggett & Platt (L&P) Automotive is the world's largest supplier of seat comfort system and suspension components to the automotive industry. Building upon this base, Leggett & Platt, together with several technical partners, has developed wireless charging technology compatible to the global standard (Qi) and to automotive EMC requirements. L&P is the first company to win a major automotive award utilizing Qi compatible wireless charging.

Technological Contribution: Leggett & Platt Automotive has developed an in-vehicle mobile device charging mechanism which is vastly more consumer friendly with its Helios wireless charging system.

Lixar

Lixar IT is an Ontario and Nova Scotia based company with 155 employees that predominately provides software services and global connected transportation services. The company provides services to automotive, airline and telecommunication industries with primary focus on the automotive industry. Lixar provides a range of services including platform development, IT backend infrastructure and design center. Lixar's services provide critical convergence between mobility and automotive and airline transportation.

Technological Contribution: Lixar contributed the cohesive design philosophy and assets for all of the companies integrated into the In-Vehicle Infotainment (IVI) system, ensuring that human factor are well represented.

Magna

Magna International is the most diversified global supplier. The company designs, develops and manufactures technologically advanced systems, assemblies, modules and components and engineers and assembles complete vehicles, primarily for sale to original equipment manufacturers of cars and light trucks. The company's capabilities include: the design, engineering, testing and manufacturing of automotive interior systems; body and chassis systems; vision systems; electronic systems; exterior systems; powertrain systems; roof systems; as well as complete vehicle engineering and assembly.

Technological Contribution: Magna International contributed integrated side light projectors and a smart rear-view mirror that enable safer driving and provide indication for others on the road.

MIS Electronics

MIS Automotive is developing and commercializing a suite of advanced, next generation Automotive Imaging Safety Sensors. Technologies employed on the APMA Connected Vehicle are key enablers to providing 360 degrees of visibility and coverage around the automobile. In addition to these products, MIS Automotive also provides Strategies Automotive Electronics Services with a focus on high reliability and globally competitive pricing.

Technological Contribution: MIS Electronics incorporated a number of next generation proximity and camera sensors in the Connected Car for front and rear-view as well as full 360-degree visual sweeps.

Pravala Networks

Its end-to-end cloud networking platform provides fast, secure, reliable connectivity between the car and the cloud. The platform consists of a gateway in the car that intelligently connects to the cloud using 3F, Wi-Fi and DSRC; and provides a Wi-Fi connection for passenger user in the car. The platform also provides a web-based policy management and reporting system.

Technological Contribution: Pravala Networks' technology in the Connected Car ensures the vehicle is always connected by leveraging its intelligent connection and policy management platform.

QNX

QNX Software Systems Limited, a subsidiary of Blackberry, is a leading vendor of operating systems, development tools, and professional services for connected embedded systems. Global leaders such as Audi, Cisco, General Electric, Lockheed Martin, and Siemens depend on QNX technology for vehicle infotainment units, network routers, medical devices, industrial automation systems, security and defense systems, and other mission- or life-critical applications. The company hold approximately 60-70 per cent of market share in infotainment operating systems and serves many OEMs in North America and around the world. Founded in 1980, QNX Software Systems is headquartered in Ottawa, Canada; its products are distributed in more than 100 countries worldwide. The company has satellite offices in Detroit, Japan, Germany and China; however, most of the R&D is carried out in its Ottawa headquarters.

Technological Contribution: QNX Software Systems provided its award winning CAR2 platform as the basis for the entire in-cabin experience, Digital Instrument Cluster concept as well as the majority of the integration effort necessary to seamlessly stitch these technologies together.

Rogers

Rogers Communications is a leading public Canadian communications and media company. It is Canada's largest provider of wireless communications services and one of Canada's leading providers of cable television, high-speed Internet and telephony services to consumers and businesses. Through Rogers Media, the company is engaged in radio and television broadcasting, televised shopping, magazines and trade publications, sports entertainment, and digital media. Because of its unique offerings, Rogers is well positioned to offer a comprehensively novel connected automotive experience.

Technological Contribution: Rogers Communications provided broadband connectivity (4G/LTE) and made the connected demonstrator truly connected.

TE Canada ULC

TE Connectivity is a $13 billion world leader in connectivity. The company designs and manufactures products at the heart of electronic connections for the world's leading industries including automotive, energy and industrial, broadband communications, consumer devices, healthcare, and aerospace and defense. TE Connectivity's long-standing commitment to innovation and engineering excellence helps its customers solve the need for more energy efficiency, always-on communications and ever-increasing productivity. With nearly 90,000 employees in over 50 countries, TE Connectivity makes connections the world relies on to work flawlessly every day. TE Connectivity's Local Interconnect Network (LIN) based RGB linear and localized ambient and courtesy interior lighting are integrated into the vehicle. OEMs can customize their lighting designs "with software", or it can be enabled to allow each individual car owner to tailor the lighting using the QNX's uniquely installed navigation screen or via smart phone. Each light engine within a vehicle can individually control color and intensity, allowing for custom lighting features vehicle-to-vehicle while keeping wiring complexity to a minimum. The LIN based integrated wireless smart phone charging unit located in the vehicle's center console. TE Connectivity's lighting solution uses advanced LED technology offering vehicle interior "personality" while using minimal power.

Technological Contribution: TE Canada incorporated LIN-based ambient lighting system in the Connected Car which provides for a very unique in-cabin customization experience.

Weather Telematics

Weather Telematics is the creator of a new innovation platform that bridges the connectivity gap between the emerging world of connected vehicles and the internet. The company has pioneered a multi-purpose, vehicle-based surface observation platform that collects environmental data at an unsurpassed hyper-local scale, which is delivered to customer in real time, and with guaranteed scientific integrity supported by standards and the provision of metadata. More specifically, Weather Telematics designs and integrates uniquely patented mobile sensing systems that enable surface travelling vehicles to deliver a whole new paradigm of strategic, spatial, and environmental intelligence for industry specific connected vehicle applications.

XYZ Interactive Technologies Inc.

XYZ Interactive provides 3D gesture recognition and touchless control sensor technology. The low cost, low power *Gesture Sensors* technology delivers a unique and natural touchless control experience to users. The company enables compelling use cases such as touchless turning of pages and control on a small screen, docking station, digital sign, display, or wearable device by simply waving the hand. The technology enables these interactions using very low cost and low power IR transmitters and receivers. Unlike camera-based solutions, XYZ Interactive can be wearable, always on, and detecting gestures and performs right up to the surface of the screen or device without any blind spots. The technology is ideal for inclusion either in a docking peripheral or in the devices themselves. XYZ Interactive is engaged with many of the key players and has a defensible competitive advantage. The company has projects and licensing deals in automotive and consumer verticals, where it was selected over camera-based technologies.