CARS Annual Report 2012
Center for Automotive Research at Stanford

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1 Summary

2012 has been a very diverse and active year for the Center for Automotive Research at Stanford (CARS), the automotive affiliates program at Stanford University. The community of industry partners has grown again substantially, a variety of events and activities was organized to connect that community of industry and research partners, and new research directions were supported to lead eventually to new programs.

The number of industry partners grew by more than one third, so that CARS now has 18 officially affiliated companies going into the new year. This growth also led to a greater diversity in interests and very broad participation in program activities that CARS offered. The addition of suppliers and service providers to the group of industry partners led to a more balanced spectrum of companies that will help to further connect with researchers from different backgrounds, which will be one of the main goals for the program going forward.

The program hosted a variety of community events over the year, some of them in cooperation with other programs on campus, such as the Revs Program. Those events ranged from smaller gatherings like class project presentations to special lectures and vehicle demonstrations that attracted up to 200 people, documenting the breadth and recognition of the automotive program. The classes that CARS organized in engineering and business were further refined compared to the schedule of previous years and helped to generate even more awareness of automotive and mobility related topics among students. This trend was also observed in a very good turnout for the resume book that CARS compiled from students for affiliates at the beginning and end of 2012.

Throughout the year CARS worked to provide a more structured approach for its program offerings, with webinars and workshops organized to discuss research opportunities in special focus fields. Beyond autonomous driving, which has been a key interest of the program since its inception, possible research directions in attentive driving and vehicle communication were discussed with affiliates. The latter turned into a separate program (V-CAP) at the end of the year and further discussions will be led with affiliates to determine if and how additional research in human factors and driving can be established at Stanford.

2 CARS Community and Network

2.1 Stanford Partners

2.1.1 The Revs Program at Stanford

2012 was the first full year with two automotive programs at Stanford: CARS and Revs. With CARS in the fourth year of its existence, the Revs Program at Stanford also grew its activities and impact. Early in the year, Reilly Brennan took over the responsibility of the Executive Director for the Revs Program, a role that had been thus far covered by CARS as well. While Revs is a donor-funded program, which supports research and education programs around many automotive related activities directly, CARS remains an industry-funded affiliates program, which cultivates industry-academia partnerships by organizing educational components and initiating research projects. The two
programs complement one another quite well and co-hosted several events such as special lectures or community gatherings.

The Revs Program intensified its research and community work during the year 2012. Research centered on the connection of neuro-science and vehicle dynamics. Progress was made in analyzing the driver’s mental workload and relating it to the driving situation. This work provides input to the design of future cars as it helps to improve driver interfaces, safety systems, and vehicle layouts. In the broader community of Revs, the program has been very successful in attracting world-class speakers to give lectures at Stanford (in some cases jointly with CARS) and to acquire additional artifacts to the Stanford Library. Faculty and staff of both programs are strongly committed to continuing a close relationship between CARS and Revs in the future, while both keeping their individual identities as industry-supported and donor-funded programs. More information on the Revs Program can be found on the program’s website: revs.stanford.edu

2.1.2 Business and Law Schools

CARS has continued to maintain its vital relationships with the Graduate School of Business (GSB) and the Law School (SLS). With the GSB, an active connection for several years through a co-instructed class (see 3.2.3 S574 – Strategic Thinking in Action / Electric Vehicle Industry) continued. Initial conversations about additional research activities in electric mobility topics also began in 2012. The connection with the SLS was further strengthened as the program “Legal Aspects of Autonomous Driving”, which was initiated by CARS, became fully operational. Conversations with policy makers at different state and federal levels to discuss regulation for autonomous vehicles and attentive driving were led jointly by CARS and the SLS.

2.1.3 Research Centers and Programs

CARS also sustained vital connections with the Precourt Energy Efficiency Center, Global Climate and Energy Program, and the Program on Urban Studies. With those connections, expressed through co-initiated projects (wireless charging), co-organized symposia (energy summit), and co-instructed classes (new mobility), a broad portfolio of activities in the sustainable mobility field was covered. Future activities in these fields are planned with the respective partners.

2.1.4 Student Groups and Projects

CARS also maintained close relationships with student groups on campus that have a specific interest in automotive or mobility related topics. The Stanford Solar Car Project (SSCP) has its home at the Volkswagen Automotive Innovation Lab (VAIL), which is operated by CARS and the Directors of CARS also play an active role in overseeing SSCP. With those contributions, CARS can be seen as a key supporter of the solar car
program, a group of about 50 undergraduate students who will race their new vehicle at the 2013 World Solar Challenge in Australia.

Another student group that partly relies on the CARS program is ME310, the three-quarter course “Project-Based Engineering Design, Innovation, and Development”, which often has students working on automotive related projects such as driver interfaces or mobility concepts, and is sponsored by industry partners. Those students sought advice for their projects from CARS and carried out some of their work at VAIL.

The Product Realization Lab (PRL) supports CARS with the operations at VAIL, which includes workshop operations and safety training. Their involvement is also testament to the growing community of researchers and students working on automotive related topics, which requires a well-coordinated approach to lab operations.

### 2.1.5 Directory of Collaborating Researchers

Early in the year, the CARS website has updated a database of faculty and researchers at Stanford who work in automotive related fields. The directory contains a list of more than 30 individuals conducting research on many different topics that apply directly or indirectly to the automobile and mobility realm in departments and research centers across the university. CARS is assisting its affiliates in establishing contacts with researchers upon request. The directory of collaborating researchers can be found on the CARS website: automotive.stanford.edu >> People

### 2.2 Industry Affiliates

Over the past 2 years, CARS has grown beyond what was imagined at its inception four years ago, adding five new affiliates during the year 2012 alone. Mercedes-Benz, Allstate Roadside Services, Volvo Group, Intel, and Delphi are now very valued members of the program, adding an even broader spectrum of industry backgrounds and interests. CARS is now affiliated with almost every major OEM, several major suppliers and insurance companies. Beyond that, the program is expanding its affiliations into the information and communication industries, which documents not just further growth in size but also in diversity. There is great interest in respective topics in automation, connectivity, alternative energy, and mobility solutions to be explored in academia-industry partnerships.

This broad spectrum of industry affiliates presents a very important component of the CARS program, as these companies – in addition to providing the funding for the program – present a tremendous opportunity to draw from with a wealth of interests and expertise. This becomes very obvious in roundtable discussions and workshops, expert lectures in classes, and other occasions when the group of CARS affiliates forms an
extremely diverse and knowledgeable community together with Stanford researchers and at times other off-campus experts. The group of affiliates also presents great opportunities for students and researchers to discuss their automotive projects with industry experts to get real-world input. In return the group of affiliates is also a very good pool of career opportunities for graduates, who are being connected with their future employers through the CARS resume book that is distributed among its affiliates.

Beginning with the new academic year, CARS adjusted the fee for the 12 months program affiliation from $30K to $32K. Another change was the implementation of just one membership level as “CARS Affiliate”. The previously used membership levels “Partner” and “Associate” were no longer being distinguished. In going forward, CARS would like to complement the spectrum of affiliates with further information and communication technology companies. Given the strong interest in attentive driving and vehicle communication, there should be much potential to add respective affiliates to complement and further enrich the program.

2.3 Extended Community and Public Communication

CARS is also maintaining an active network with groups and individuals at non-affiliated organizations. Examples are government organizations on a federal and state level, with which an exchange on current issues regarding personal mobility is maintained through mutual visits and occasional roundtable discussions with affiliates. A similar exchange is being cultivated with other academic groups at universities in the area (especially UC Berkeley, Santa Clara University and California Polytechnic University) and nationwide, or interest groups such as Silicon Valley Robotics or Silicon Valley Innovation Institute.

CARS also maintains numerous connections with companies that are not officially affiliated with the program but participate in the community on a case-by-case basis. The spectrum in that regard ranges from many local ICT companies that participate in workshops at CARS as there is fit, electric vehicle companies in the Bay Area, and many start-up businesses in the field, some of which were featured in the Vehicle Concept Showcase that CARS organized in spring.

This extended community shows the very wide network that CARS has established in the geographical and topical area of Automotive in Silicon Valley. This role is also being recognized in speaking engagements that the faculty and staff of the program receive worldwide. During the past year the CARS Directors gave invited talks outside the university in many places in the country and in Europe as well as Korea and Japan. In addition to these talks many media inquiries, mostly centered on autonomous driving and electric mobility, document the level of automotive expertise that is recognized worldwide and supported by the integrative nature of the CARS program (see also 3.6 Media and Public Relations).

3 CARS Activities and Events

3.1 Research Initiation

CARS helped to get a variety of topics established as research directions at Stanford and presented key themes and researchers to affiliates, such as vehicle communication,
wireless charging, and attentive driving. The topic Legal Aspects of Autonomous Driving, which had been supported by CARS from the beginning and is often referenced as a very good example for how the affiliates program is an incubator for new research activities on campus, grew to a size of 9 supporting companies during the year. As this post-doctoral fellowship is now a separate program established at the Stanford Law School’s Center for Internet and Society (CIS), it is reported independently from CARS.

3.1.1 Vehicle Communication

Research topics in the vehicle communication realm had been discussed with affiliates and Stanford researchers already for a long time before a workshop was held in April of the year with affiliates and other interested companies to formulate directions for a potential research program. Throughout the summer CARS worked to establish an affiliates program as a framework to connect researchers and industry partners to address research questions in vehicle communication together. Such a program was finally launched in fall of 2012 with Prof. Paulraj being the faculty director and CARS providing administrative support. During the remainder of the year, CARS helped to solicit support from industry. The objective of the program, which is called Vehicle-Communication Affiliates Program (V-CAP), is to research opportunities to use LTE / 4G standards for improved safety and efficiency of vehicles. This program is aiming to complement DSRC-based V2V and V2I communication with the rising performance and ubiquity of 4G mobile data networks as well as to find specific areas to influence future 4G network evolution.

It is expected that this program will begin research activities toward the end of the first quarter in 2013, which will be another example of how CARS helps to initiate new projects on campus. More information on the progress and details of V-CAP can be found on the program’s website: v-cap.stanford.edu

3.1.2 Wireless Charging

Throughout the year CARS continued to support the program in the Electrical Engineering Department, directed by Prof. Fan, that is aiming to charge electric vehicles while driving. The project has been supported together with Stanford’s Global Climate and Energy Program (GCEP) for over 3 years, and the CARS affiliates have been updated on the progress regularly. Through the on-campus network that CARS maintains, an additional component was added to the research program, which now also considers the changes and components that are necessary in the road surface when coils for magneto-resonance power transmission are implemented into the pavement.

At the beginning of the year, CARS also instructed a student study to investigate the need for autonomous vehicle control in the lateral direction in order to maximize transfer efficiency between the road-side and vehicle-side coils. The study found that lateral deviation caused by average drivers does not impede the transfer rate significantly so
that no autonomous control is required. However, the study pointed out that an autonomous control concept could be realized potentially at a lower cost given that the magnetic field acts as a sensor for lateral tracking error.

At the end of the year, the research program in wireless charging directed by Prof. Fan was at a stage where the researchers could confirm the initial simulations, which had already shown very high transfer efficiency, with practical test in a lab environment. Those experiments will be scaled up over the following year with a setup that will show the power transfer to a full-scale driving vehicle, for which industry partners are being sought.

3.1.3 Attentive Driving

CARS hosted a roundtable discussion in August with a Board Member of the NTSB (National Traffic Safety Board) to review problems through distracted driving and ways to improve situational awareness of drivers. While the discussion at the meeting centered on the human capabilities of controlling vehicles, avoiding accidents, and maintaining awareness of the driving situation, the conversation later on gravitated toward research directions in the field. It was discussed that standards to quantify levels of distractions and attentiveness respectively might need to be investigated further, especially when combining data from accident statistics, simulator experiments, and real-world driving scenarios. At the end of the year 2012 those discussions were still ongoing as to what extent respective research might be established at Stanford. CARS will continue this exchange with its affiliates and other potential partners.

3.2 Student Interaction: Classes, Projects, Recruiting

CARS is quite active in establishing and instructing automotive relevant classes at Stanford. The following sections highlight those classes with direct involvement of the program. In addition, CARS also maintains a directory of automotive relevant classes, in order to provide students with a comprehensive overview of those courses to complement their curriculum in this direction, if desired. This directory also provides information on student activities at Stanford, which also offer industry partners opportunities to get engaged in lecture series or class projects. The topics range from vehicle dynamics to legal considerations, from business strategies to urban studies, and beyond. The directory also shows that different schools and departments at Stanford are offering a variety of courses with automotive relevance. Many of those courses are new and made possible through the support of the Revs Program at Stanford, especially those in American History and Art History. The directory of relevant courses can be found at: automotive.stanford.edu >> classes/jobs

3.2.1 ME302 – The Future of the Automobile

In the winter quarter, CARS' hallmark class ME302 “The Future of the Automobile” took a broad perspective on personal mobility, with almost 50 students enrolled. The seminar hosted a total of 8 guest lectures in autonomous driving, electric mobility, connected vehicles, and car sharing concepts. Most lectures were held by CARS affiliates, which offered ample opportunities to connect industry partners with students.

In the spring quarter, with 40 students enrolled, ME302 took a specific look at “Intelligent Vehicles” through a combination of lectures on driver assistance systems and vehicle
communication concepts. Most lectures, which included lab sessions that introduced both research and production vehicles and systems to the students as a hands-on experience at VAIL, were held again by CARS affiliates.

In the fall quarter, the format of ME302 was refined to offer in the first half of the term a more general background of automotive facts and theory in order to provide for an even more educated discussion in the guest lectures during the second half. That way the students first learned basics about performance, safety, energy, cost, and production of automobiles, which was appreciated as a broader context. Later on the well-proven setup with guest lectures by CARS affiliates was maintained to introduce driver assistance systems, electric vehicles, vehicle communications, and mobility concepts to the class. About 40 students were enrolled again during the fall term of the 2012/2013 academic year.

In order to offer a repository of all ME302 “The Future of the Automobile” lectures that have been presented since the beginning of the seminar series in 2009, a directory of all presentations that were offered for public sharing was established. The presentations with links to the respective files can be found at: me302.stanford.edu >> Lecture Archive

3.2.2 ME185 – Electric Vehicle Design

For the second time CARS offered ME185 “Electric Vehicle Design”, a project-based class involving design and prototyping of electric vehicles. The concept of the class is that students learn the fundamentals of vehicle design and apply the knowledge simultaneously as they form teams and work on projects involving concept, specifications, structure, systems, integration, assembly, and testing. During the spring quarter the class of twelve students produced four electrified vehicle prototypes and two EV specific design proposals. At the end of the term the student teams showed their electric scooters, karts, and more at an informal gathering at VAIL, to which the community of academics, industry, and aficionados was invited. The class got outstanding reviews from the students and will be offered again in 2013 to introduce students to automotive topics through a hands-on experience. More information on the course ME185 can be found on the course’s website: me185.stanford.edu

3.2.3 S574 – Strategic Thinking in Action / Electric Vehicle Industry

CARS has maintained a close relationship with Prof. Burgelman at the Graduate School of Business at Stanford (GSB) for several years, which also led to a co-instructed seminar titled “Strategic Thinking in Action – In Business and Beyond”. This management seminar, offered to second year MBA students, focused on the evolving global electric vehicle industry in 2020. While the instructors provided relevant background regarding strategy making and the electric automobile industry, guest
lectures by Ford, Nissan, and ChargePoint added significantly to the discussion in class. The students were required to define a project topic to develop a strategy paper as a group work. The topics for the final paper were “Charging Infrastructure in the United States”, “Electric Vehicle Supply Chain in Europe”, and “Electric Vehicle Startups in China”. Despite the relatively small class size of 15 students, the seminar not only repeatedly fulfills an important mission of educating MBA students in automotive and strategy topics, but also connects the engineering and business disciplines as students from different backgrounds are enrolled. In addition, the project papers from the students offer insights into potential strategies for the industry to consider as companies are getting more and more engaged in electric mobility. Therefore, CARS made some of the project papers available to its affiliates.

### 3.2.4 Other Class Engagements

In addition to the classes that CARS directly organizes and instructs, the program also participated in many other teaching activities. Automotive expertise is often requested for seminars and courses taught by other instructors, such as in “Electric Automobiles and Aircraft”, “The Automobile and the City”, “Global Entrepreneurial Marketing”, the “Energy @ Stanford & SLAC Conference”, and others. Through those engagements, the program brings automotive and mobility topics to lectures and grows the community of interested students, which fits well with the program’s mission to advance automotive topics in research labs and classrooms.

In addition to offering lectures in other classes, CARS also helped to connect classes with potential industry supporters for term projects. For instance the classes ME113 “Mechanical Engineering Design” and ME310 “Project-Based Engineering Design” regularly seek the support of the CARS program to connect students and companies for a mutually beneficial prototyping experience. Based on the proposals from industry, students then work on those problem statements, brainstorm directions, sketch out possible solutions, and prototype in the end innovative concepts to be showcased at the end-of-term project presentations. Industry partners were contacted at the beginning of the respective terms through CARS to become part of this interactive process with their assignments.

### 3.2.5 Student Projects

CARS also mentored numerous students with their term projects or independent studies, which is an important component to initiate new activities on campus that could in the end even become research programs. Those projects also provide new insights for scholars and affiliates to the respective fields as students take deep-dives into automotive and mobility related topics for their studies.
One independent study conducted throughout the academic year 2011/2012 centered on risk assessment and standards for autonomous driving. The respective work of the winter quarter compared autonomous automobiles to other autonomous vehicles such as farming equipment, spacecraft, and others. During the spring quarter a draft standard for autonomous highway driving was formulated based on existing standards for intelligent transport systems and on the technological achievements in other automated vehicles such as aircraft. The main goal of the draft was to suggest a basis for the development of autonomous vehicles, which was devised as functional specifications as well as test procedures and requirements.

A group of students in the class "Global Entrepreneurial Marketing" chose “Autonomous Driving Deployment Strategies” as their topic for the winter quarter to develop a market deployment strategy. In order to get an overview on consumers’ expectations regarding autonomous driving, the group created a public survey that was sent out widely to get feedback regarding what level of control consumers want to keep over their vehicle and how much they would be willing to pay for an autonomous car. The non-representative results from almost 1,000 respondents showed that the majority of consumers might want to retain a basic level of control over the vehicle and that an additional price of $10k presents a major threshold for the adoption of this technology. The findings of the study were presented to the CARS affiliates in the April webinar.

3.2.6 Resume Book and Career Fairs

In the year 2012 CARS compiled its resume book twice, as the process and timing was adapted to better align with the student application and corporate hiring procedures. Therefore, the compilations were sent out to affiliates on a CD in early February and mid November of the year. The CDs contained a searchable spreadsheet with the student’s summary data and the resumes linked as PDF documents. Because the resume books were sent out twice in the year due to the changed date and improved process, this also offered a good comparison of the respective turnouts as about 70 resumes in the first run and about 100 in the second were forwarded to about 30 and 40 individuals, respectively, at the affiliated companies. This shows that in addition to the growth of the CARS community on- and off-campus over the year, the new timing fits better with the general hiring process. The feedback from students as well as industry shows that the resume book is a very much appreciated service, which has become a staple of the CARS program.

Beyond the resume book, CARS also helps its affiliates by forwarding job offers to its student mailing list, which comprises well above 500 individuals that have expressed interest in automotive and mobility related topics. CARS assists its partners in identifying the right opportunities to attend career fairs and other recruiting activities on campus so that the companies can connect with future employees through the program.
3.3 Workshops, Expert Meetings, Community Events

3.3.1 Workshops and Expert Meetings

Throughout the year, CARS organized numerous meetings to bring academia and industry together and consider directions for potential research programs. One example for this was meetings to discuss opportunities in vehicle communication systems. During those expert discussions it was emphasized by affiliates and other industry attendees that supplements for the government-led initiative in DSRC would be worthwhile to investigate in order to improve traffic safety and efficiency. The key meetings in this field were held in April and June giving industry experts and Stanford researchers ample opportunity to exchange standpoints and ideas. This exchange eventually led to the Vehicle-Communication Affiliates Program (V-CAP), which is being launched with the help of CARS at the time of writing of this report (see also 3.1.1 Vehicle Communication).

In April CARS hosted a workshop "Proceedings in Autonomous Driving". The objective was to bring academia and industry together and review current proceedings in autonomous driving and discuss necessary actions for the evolution from driver assistance systems to fully autonomous vehicles. During the day-long event the affiliates had an open exchange on the legislative and regulatory processes in general. The discussion was based on an overview of the current regulation and initiatives for autonomous driving in different states with particular focus on Nevada, California, Florida, and Hawaii as well as the 1949 Geneva and 1968 Vienna Conventions on Road Traffic. In the end a need for further considerations regarding definitions of terms, certification of systems, and communication in public was identified, which were topics for the follow-up workshop in early December of the year (which was held after this report was written so the respective outcome will therefore be communicated to affiliates in the new year).

In August, CARS hosted a Virtual and Augmented Reality Research Workshop, which also marked the first step in the series of research workshops that CARS is planning together with the Stanford Center for Professional Development (SCPD). The all-day event consisted of expert talks, lab visits, and hands-on demonstrations to show the breadth of respective research activities at Stanford. The group discussed current research and future trends in the field, which might eventually be considered for automotive applications. The general setup of this workshop was also supposed to present the prototype for about 2-3 research workshops per year, which CARS will offer affiliates to come together and learn from Stanford researchers about their work and initiate further connections between academia and industry.

In August, CARS hosted an Attentive Driving Roundtable with Mark Rosekind, Board Member at the NTSB (National Transportation Safety Board). The exchange offered the attending researchers and affiliates an overview of the more than a decade of work in driver distraction research and recommendations that came out of it. The following discussion centered on necessary steps to quantify driver distraction / awareness and
how standards can help to formulate guidelines for vehicles and user interface design. The conversation was extended throughout the fall of 2012 and might eventually lead to more research activities in respective fields at Stanford in collaboration with industry and government partners (see also 3.1.3 Attentive Driving).

CARS also worked together with other groups at the university to jointly organize research symposia, which mostly entertained topics in the sustainable mobility field. One example was the Silicon Valley Energy Summit in June, when CARS organized the Vehicle Electrification Panel Discussion, which discussed technology, consumer, and policy trends for plug-in vehicles. And also in June the Stanford Program on Regions of Innovation and Entrepreneurship hosted a symposium on Innovations for Smart Green Cities, where CARS gave an overview on how autonomous and connected vehicles can contribute to a safer and more efficient transportation model. Those examples show that other on-campus groups seek out the CARS program as a source for general information and expert insights to be considered for research directions and trend discussions in the respective fields.

3.3.2 Community Events

Another very important component of CARS is the different community events that the program organizes primarily to bring students, researchers, and affiliates together. Those gathering are often organized around a special lecture or project demonstration. A few examples are being highlighted in the following sections.

During 2012, CARS collaborated with the Revs Program to organize special lectures, which were held as Open Garage Talks at the Volkswagen Automotive Innovation Lab (VAIL). In May the first event of this series attracted 180 attendees to hear Pulitzer Prize Winner Paul Ingrassia draw connections from the assembly lines of Henry Ford, to Route 66, to the success of European and Japanese cars in the U.S., and more. The talk itself and the general setup of the event were very well received by the attendees from academia, industry, and interest groups. The event provided an opportunity to connect with people from many different relevant fields and to follow inspiring thoughts from a renowned expert in the automotive realm. The next Open Garage Talk that CARS co-hosted was "Designing Difference in A World of Sameness" by former BMW Head of Design Chris Bangle, for which well over 200 people registered, making it one of the most popular event that CARS has ever hosted. The setup of the Open Garage Talks will be continued for other special lectures that CARS and Revs will co-host in the future as given its success in attracting renowned speakers to campus and further building the automotive community.

Picture 8: Open Garage Talk
Other events that provide ample opportunity to bring the automotive community of students, researchers, and affiliates together include a reception for the students in the “Electric Vehicle Design” class, which was held in June. At the end of the spring quarter, student teams showed their electric vehicle creations in an informal gathering at VAIL and connected with researchers and affiliates celebrating the end of the academic year (see also 3.2.2 ME185 – Electric Vehicle Design). Another gathering with the purpose to celebrate was a special lecture on vehicle communication, which was organized in December. Luca Delgrossi of Mercedes-Benz R&D N.A. had co-authored a book on Vehicle Safety Communications, which was introduced in a community event at VAIL attracting more than 60 attendees from academia and industry. The setting for this event was again an open format with an overview presentation and ample opportunity for networking.

In a different event setup, CARS hosted the second Vehicle Concept Showcase at Stanford in June when Stanford students and local entrepreneurs presented their innovative vehicle concepts. The event attracted a community of researchers, entrepreneurs, and enthusiasts in the mobility field to discuss those concepts and meet the people behind the projects. 8 groups of mobility innovators with their vehicle concepts followed the invitation to VAIL and presented their work. The hour-long showcase event was attended by about 120 people and was framed with a networking reception that offered ample opportunity to gather around the vehicles for further discussion and to meet the project teams. Another big community event with showcasing technology concepts at VAIL was the Robot Block Party in April, where more than a dozen groups and companies exhibited their robotics related projects and attracted well over a thousand attendees from academia, industry, and general public. This event has become a regular gathering every April at VAIL with the Center for Internet and Society (CIS) together with some CARS affiliates largely organizing the activities. The Block Party is another example of how the automotive affiliates program and the research lab present a very good network to bring interested groups together and provide appropriate space to host community events.

A very special opportunity came to CARS in April when the Chairman of Ferrari, Luca di Montezemolo, visited Stanford University for a special lecture at the Business School (prior to that he had also visited the CARS program). The public talk, which was not organized by CARS, attracted many interested students, researchers, and affiliates so that CARS hosted a community lunch after the talk to discuss current automotive topics and connect academia with industry.
3.4 Regular Affiliates Meetings and Communication

3.4.1 Affiliates Updates and Webinars

The CARS Monthly Meetings had been a good way to update all affiliates and had contributed significantly to establishing a strong community sense and identification within the CARS program during the first two years of the program. However, with the program growing and affiliates in many different locations and time zones, it was decided to evolve the setting of the regular affiliate updates. Therefore the regular exchange was changed from monthly in-person meetings to webinars now every two months. These online meetings highlight research topics in fields related to automotive topics. The goal of the webinars is to further connect researchers and affiliates providing more opportunities for collaboration. The organizational information regarding the CARS program, such as event planning and administrative matters, is distributed as a briefing memo in the week prior to the webinars so that it can be discussed briefly at the beginning of the online meeting if needed. This new setup was appreciated by the affiliates as a more efficient way to distribute general information and to focus on research topics.

The first four webinars, which were also made available as voice- and slide-recording, covered topics in consumer expectations regarding autonomous driving, new concepts for driver interfaces, a comparison of different electric vehicle charging concepts, and smart grid applications for vehicle charging. The webinars offer a breadth of topics so that industry partners get an overview of automotive relevant topics that are being pursued at the university beyond the well-known research groups. This setting of briefing memos and online webinars will be kept for the affiliates program for the foreseeable future to distribute research relevant and organizational information.

3.4.2 Newsletter and Website

The regular CARS Newsletter plays a key role in keeping affiliates informed with events and lectures, program organization, research activities, and class projects. It is currently being sent out to more than 300 individuals at the 18 industry partners and Stanford affiliates. The feedback from its readers shows that the efficient and concise way of communication and information is very much appreciated, so that the newsletter has become a very integral part of the CARS program.

The CARS website also serves as a repository for briefings and presentations where affiliates can find notes and information from previous meetings. The website was not updated to the extent it was anticipated at the beginning of 2012. A database of automotive relevant publications was still under development at the end of the year and will probably made available with a re-launch of the website in 2013. The website can be found at http://automotive.stanford.edu

3.5 Facilities and Infrastructure

The facilities and infrastructure that CARS provides are primarily the Volkswagen Automotive Innovation Lab (VAIL) in the Automotive Innovation Facility (AIF) on 473 Oak Rd. on Stanford campus. Throughout the year VAIL has served as the home to a variety of research groups such as the Communication between Human and Interactive Media Lab (Prof. Cliff Nass), the Dynamic Design Lab (Prof. Chris Gerdes), the Autonomous
Driving Group in Computer Science (Prof. Vaughan Pratt), and project groups in electric mobility consumer behavior (Dr. Martin Steinert). In addition to the research groups, VAIL provides space and infrastructure for student groups such as the Stanford Solar Car Project and class projects like “Electric Vehicle Design” and “Design Restoration”.

With all those research and student groups, VAIL presents a lab community of more than 100 registered members. While CARS maintains operational control over the facility and infrastructure, the program sought additional support from building managers at the School of Engineering and lab assistance from the Product Realization Lab (PRL). With this support VAIL and CARS should be positioned to accommodate future research and student project needs and continue to be a hub for almost all automotive activities on campus. The Directors of CARS feel that this is a very important part of the program’s mission in advancing research and education in the automotive realm.

### 3.6 Media and Public Relations

CARS also receives many interview / filming requests, which documents the high interest in automotive research in Silicon Valley and also the particular recognition the program gets as a hub for those activities. In addition to the specific media coverage that individual faculty and research groups received during the year, (such as Prof. Gerdes with autonomous driving at the limits, Prof. Cliff Nass with driver-vehicle interaction, and Bryant Walker Smith with legal aspects of autonomous driving), some more general automotive media coverage that CARS received should be mentioned.

In January, Co.Exist, an online version of the FastCompany Magazine, spoke with CARS to find out more about automotive research at Stanford, and what main trends researchers see for the automobile in the near future. The autonomous driving and wireless charging projects were highlighted in the online article that was published. Those topics were also picked up by other media, such as MSNBC, which focused on the challenges a mix of autonomous and human driven vehicles is expected to present to drivers, authorities, and manufacturers. In May, CTV News Channel discussed where autonomous driving is headed and when autonomous vehicles will be widely deployed in a live TV interview with CARS. In June, The Dish Daily, an off-campus publication by Stanford students and others, covered the "Electric Vehicle Design" class and the community event, which showcased the student projects at the end of the quarter. By far the most media requests throughout the year were in regards to the proceedings in autonomous driving, especially as Nevada and California moved ahead with respective regulation. During the year CARS also received several requests to discuss general trends in the automotive space, such as directions for the automotive industry, consumer expectations, and product developments. While CARS does not see itself positioned to comment on all topics that are being brought forward by the media, the broad variety
and frequency of requests document the status that the program has gained as a source for insights in a field of high public interest.

4 Outlook

As CARS looks forward to its fifth year in existence, the program remains focused on maintaining the diverse relationships with individuals and organizations both on- and off-campus. With regards to the focus areas of the program, it needs to be discussed if the four fields of “Driver Assistance”, “Connected Mobility”, “Alternative Energy”, and “Mobile Society” should continue to be pursued with similar attention or if the focus should be narrowed to a subset of those topics. The preservation of the existing community and the reassessment of the topical focus for the program will guide the CARS activities over the next year.

4.1 Research and Education

Autonomous Driving has been a very strong topic for the CARS program from the beginning. In fact, it can be argued that company interest in that topic has driven many organizations to Stanford who subsequently joined the program. Over the past three years, CARS also cultivated three other directions, so that the four themes “Driver Assistance”, “Connected Mobility”, “Alternative Energy”, and “Mobile Society” are considered to address a very broad portfolio of aspects regarding the future of the automobile. Over the past year the connected mobility field has also grown in importance within the CARS program, with the launch of the Vehicle-Communication Affiliates Program (V-CAP) emphasizing that direction. In addition the driver assistance and connected mobility fields are closely connected and might complement one another very well. Therefore it might be considered to have those two topics as the primary themes for CARS, while the alternative energy and mobile society fields might become secondary themes. Another topic of great interest for academia and industry is “Human Factors” with much consideration for situation awareness or attentive driving. With the industry working on many different topics in that area, Stanford research from related fields could be applied to respective problem statements. Therefore those opportunities should be evaluated in the next year regarding potential for collaboration.

CARS started to organize research workshops together with SCPD (Stanford Center for Professional Development) this year and will continue to do so. It is anticipated to have 2-3 workshops scheduled per year, which are supposed to connect researchers and industry. Topics that are considered for the next year are mobile computing, data security, advanced materials, combustion engines and fuel cells. In addition to the typically daylong workshops, the CARS webinars will resume in February and are scheduled with a two-month frequency to provide brief snapshots of relevant work in a 45min online meeting. The first topics for the year will probably be related to sensor technologies or optimization for automated vehicles.

Regarding the regular classes and seminars, CARS plans to maintain the existing schedule of “The Future of the Automobile” and “Strategies for the Automotive Industry” in fall, and “Electric Vehicle Design” in spring.
4.2 Community

As CARS has grown substantially in terms of industry affiliates over the past 2 years, it is not necessarily planned to maintain that growth trajectory over the next years. It is rather planned to preserve an active community of industry partners and academics. Therefore CARS would like to work more with its affiliates to connect with Stanford researchers on different levels, which can be informal exchanges, expert roundtables, workshops, and eventually research engagements. With the large number of industry partners in the CARS program, it will be a primary objective to establish further connections with on-campus researchers, particularly those who may not yet be involved in automotive research. In order to further engage researchers in automotive and mobility relevant topics, CARS will offer specific topics and events in a systematic approach to match the interests of researchers and affiliates.