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GM has been an early adopter and very involved with industrial robots since our initial collaboration with Joe Engelberger in GM's first robot application in 1961. We now are at a point where our manufacturing operations are supported by a fleet of some 25,000 robots in operation world wide. GM has influenced the industry over the years by leading development efforts in servo electric welding robots, paint application robots, the Unimate PUMA robot for light assembly, and fixturing robots with Fanuc.

While much has changed and improved in industrial robotics over the years, much has remained the same. It can be observed that in a variety of applications, many of the manufacturing techniques used to enable the use of early robots are still in use today. The structured environment that we establish that enables robots to perform their tasks actually limits flexibility and drives a significant cost penalty for using robots. There has been some progress in enabling robots to operate in manufacturing operations with less structure, but robot capability in this area is very limited. This "robot capability gap" persists and limits the range of applications and business conditions under which robotics provides a feasible commercial alternative to other means of implementing manufacturing processes. This gap is especially evident in our industry when examining our final assembly process. (for those who may be unfamiliar with automotive manufacturing processes, a tutorial may be found with the following link: http://www.gm.com/explore/education/9-12/making_vehicles/manufacturing/index.html)

From our perspective, rooted in the traditional definition what an industrial robot is (the traditional Robotics Industries Association (RIA) definition of an industrial robot: "A reprogrammable, multi-functional machine designed to manipulate material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks."), we observe the recent activity in the "new robotics". Current R&D activities in the "new robotics" is making efforts in the industrial side look small. The momentum in the "new robotics" areas have caught our attention and we're fascinated with the possibilities. We continue to observe that technology for the "un-industrial" robot applications in the areas of space, military, and consumer robotics have been expanding rapidly. Looking forward, we see many advances and synergies possible with the new robotics, both in our manufacturing operations and

products. We see the electrification of the vehicle as an inevitable next step and major advances are being made in energy storage and conversion. This will allow a level of control unprecedented in the history of the automobile. It has been observed that these automotive advances might be a contribution to the new robotics, since energy storage, density, and power conversion are all important in mobile systems. Recent strides in the demonstration of autonomous vehicles certainly challenges our traditional robotics thinking when we consider the potential for manufacturing robots to function in a less structured environment.

We look forward to participating in the upcoming workshop as a potential end customer and sharing our view of the priorities for a more focused national R&D agenda. From an end user perspective, we believe that a new next generation of assembly automation can be anticipated that significantly reduces the reliance on fixturing, mechanical structure and conventional sense-plan-act programming.

This capability would enable assembly automation with a set of little or no more infrastructure requirements than would a completely manual process. These new assembly processes would exploit the existence of a flexible robot perception system as an integral component of a three part strategy that includes highly flexible robots/end effectors, flexible perception, and safe integration/harmony with people also performing tasks in the assembly process.

The cognitive component of the perception system would facilitate the “assignment” of the automation to a set of assembly tasks and/or assistance to others performing a task not yet appropriate for automation. This capability will also enable the rapid “reassignment” of the automation to other tasks as required by production mix and business needs. We stand to benefit from the flexibility and productivity that this form of automation brings to our processes while elevating the capabilities of our people in the pursuit to provide our customers with quality products that are manufactured in a safe and environmentally friendly way.

In summary, we would be bringing our insight and support for the following research areas:

- Autonomous Assembly
- Safe Integration of People & Robots
- Flexible Perception