[NFB-BDC Logo Here]

NFB Blind Driver Challenge 2006

Rules

2005-02-24

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1 Introduction

1.1 Purpose

Our broader goals with the Blind Driver Challenge project are to:

- Directly stimulate innovation in development of non-visual interfaces for ordinary road vehicles.
- Indirectly encourage development of technologies necessary to implement a fully functional vehicle for blind people that can operate in all of the standard scenarios in which a normal sighted-driver car can operate.

There are a number of collateral, broadly applicable benefits from this contest that are unrelated to blindness issues:

- Development of systems for providing greater situational awareness for anyone performing highly complex, time critical tasks. Examples of such tasks would be flying aircraft, operation of high risk manufacturing elements and medical procedures.
- Display of rich information in real time where the heads up environment is already saturated, such as surgery, combat vehicles, survey vehicles, etc.
- Development of versatile 3-D mapping and navigation software may benefit remote-driving vehicles such as rovers on Mars, moons, etc.
- Improvement of sighted-driving simulators through enhancement of understanding of non-visual distractions.
- Virtual Reality developers would benefits from additional mechanisms to provide a richer, all-senses working environment.

We understand that the primary goal of creating a versatile vehicle that can be driven by blind people is very ambitious. We don't expect to be able to accomplish it very quickly. However, the path from here to there seems fairly clear, so we're eager to begin and take it a step at a time.

1.1.1 Long-term plan

To stimulate innovation in this space and to systematically achieve certain clearly defined incremental engineering goals, there will be a series of periodic Blind Driving Challenge engineering contest events. After the primary engineering goals have been accomplished, there will be a Master Blind Driver Challenge, which will demonstrate the full range of technologies developed up to that point.

- A Master Blind Driving Challenge, which will occur [some, TBD] years in the future.

  The Master Blind Driving Challenge will be a set of tasks that encompass exemplars from the full list of Real-World Challenge Scenarios listed below. Multiple exemplar tasks for each essential challenge scenario may be used. The real goal in accomplishing this set of tasks is to definitively prove to the world that blind driving is feasible and safe.

The Blind Driving Master Challenge will necessarily occur in real-world settings. This will underscore the Challenge's test validity as well as attract more public attention.

We tentatively envision a multi-hour or multi-day, multi-state Road Rally that will encompass all of the representative driving tasks over some substantial and highly variable geographical area. Unique features of this Road Rally would be strict (and technologically enforced) requirements to obey all traffic laws, and the presence of blind drivers.

During the competition there will be a licensed sighted driver onboard who will be able to take control – to drive using normal controls – at any instance. Vehicles will be instrumented to record any sighted-driver intervention, which will disqualify the team from the race. The blind person will actually control the vehicle for all normal operation.

- A series of periodic Blind Driving Challenge events. These Challenges will be more complex in structure in order to robustly attack the component technical challenges of general-purpose vehicle. These component technical challenges fortunately map fairly well onto clusters of typical driving scenarios. The goal here is that the Intermediate Challenges will prove the vehicle's viability in a given set of tasks, whereas the later Master Challenge will be primarily a public demonstration of capabilities, though the Master Challenge will also give teams a chance to show off total-system fitness and compete on that level.

  Some Intermediate Challenge tasks may be broken into multiple stages, with each stage having two successive iterations. In the first iteration, basic proof-of-concept tasks will be performed. In the second iteration, designs will be refined based on lessons learned in the previous round, and more difficult stress-testing tasks will be administered. We stress that we believe this iterative approach will result in vehicles having better overall design for the Master Blind Driving Challenge than would follow if the a more minimally challenging path were taken. New contestant teams may join in at any round, but cumulative experience will obviously be of considerable benefit.

  - The tentative schedule for Intermediate Challenges:
    1. Ghost Town #1 (first year, September 2006)
       - Tasks include basic driving tasks related to navigation in known space
         - Positioning and lane maintenance in various types of suburban roads.
         - Parallel parking
         - Parking in large parking lots
         - Parking in driveways
         - Detecting and avoiding fixed obstacles (includes some in-road obstacles)
         - No moving objects
         - No map surprises

        - May not include dynamic traffic controls (signals) (?)
    - Technical objectives clustered around
        - High-resolution 3D Mapping
        - Real-time positioning within those maps
        - Applying road navigation logic & rules/constrains to dense maps
        - Includes some stationary object surprises
        - Obstacle detection and avoidance
        - Integration of variable autonomy/variable control with object avoidance and road navigation rules
        - Development of rich Driver/Vehicle Interfaces for control fidelity, safety, and driver satisfaction
    - "Open" participation only – all teams supply their own vehicles
2. Ghost Town #2 (the next year)
    - More complex tasks (including stress cases) related to mapping and navigation in known space
    - Still no moving objects
    - Includes some map & stationary object surprises
    - Includes traffic controls (signs, lights, cones)
    - "Open" participation only – all teams supply their own vehicles
3. Suburbs #1 (third year)
    - "open" participation, plus option to use NFB standard vehicle
    - more complex tasks related to mapping and navigation in known space
        - now including some moving objects
            - Pedestrians in typical situations
            - Vehicles
            - Random stuff
        - more complex traffic rules
        - more complex unexpected-event situations
    - Parallel parking with large surrounding vehicles
    - Parking in parking lots with moving obstructions
    - Parking in driveways with oncoming traffic in the street
    - "Open" participation, plus option to use NFB standard vehicle (which would compete against the open challengers)
4. Suburbs #2
    - "Open" participation, plus option to use NFB standard vehicle
    - More complex tasks related to mapping and navigation in known space
        - Now including more moving objects for stress testing
            - Pedestrians in groups not obeying traffic controls

            - Pedestrians walking into streets
            - Vehicles behaving unexpectedly
            - Random stuff
        - More complex traffic rules
        - traffic control failures (e.g., can't detect light status)
        - more complex unexpected-event situations
        - Cars braking suddenly
        - Cars backing up in front
        - Merging at yield, odd-shaped intersections, etc.
    - Parallel parking when one of the cars moves
    - Parallel parking with someone waiting behind/blocking

5. Wall Street
   The main objective of this cluster of tasks is to test dense urban driving scenarios to stress moving object avoidance and complex traffic rules. Given the similarity to previous task clusters, a single iteration may be sufficient.
    - Lots of cars behaving poorly, moving at various speeds
    - Lots of people behaving poorly
    - Bicyclists in the street
    - Parking in parking structures
    - Valet parking
    - Parking at meters on the street
    - Pick up or drop off passenger at street or corner
    - Multi-lane intersections
    - Construction blocking lanes
6. Road Trips #1
    - Rural roads with few landmarks
    - Highways behaving well
        - Merges
        - Exits
        - Lane changes
    - Tunnels (no GPS availability)
    - Refueling at gas stations
    - Separate test category for automated behavior in simulated quick-reaction scenarios
        - Pedestrians and other surprises in the road
        - Accidents involving multiple cars in close proximity braking hard and changing lanes
7. Road Trips #2
    - Rural roads with no landmarks
    - Highways most difficult
        - Merges
        - Lane changes
        - Accidents
            - Lane constriction
        - Construction
            - Signs
            - Cones

- Police directing traffic
- Turned cars

It may make more sense to have an Intermediate Challenge round or two focusing on dense traffic stress scenarios than on later iterations of Road Trip scenarios.

The sequence of Intermediate Challenge rounds will be revised after each round.

1.1.2 Objectives for the 2006 Blind Driving Challenge round

Technical objectives for the first round will be clustered around development of core underlying software that we believe will be essential for all later rounds.

- **High-resolution 3D Mapping.** We assume that the ability to make assumptions about fixed objects in the environment will be invaluable in enabling travel at conventional speeds, easier (or automatic) positioning within lanes, more reliable adherence to traffic controls (stop signs), etc.
- **Real-time positioning within those maps.** This includes development of algorithms for identifying and localizing relevant landmarks from real-time sensor feedback.
- **Applying road navigation logic & rules/constraints to dense maps.** We assume that navigating paved roads at conventional speeds will require application of intelligent assistance for simplification of navigation options whenever feasible.
- **Stationary obstacle detection and avoidance.** Don't hit the things that don't move (whether permanent or not).
- **Integration of variable autonomy/variable control with object avoidance and road navigation rules.** Drivers should be able to assume control of the vehicle to whatever degree of resolution that they want, at a moment's notice.
- **Development of rich Driver/Vehicle Interfaces for control fidelity, safety, and driver satisfaction.** How can the relevant information needed for driving best be conveyed to the driver? How can the driver best control the vehicle?

1.1.3 Addressing obvious concerns & Moderating expectations

We understand that measuring the safety of blind-driven vehicles in controlled environments is extremely difficult, and that more methodical stress testing of a blind-drivable vehicle will be required in the years ahead prior to getting regulatory approval for actual blind driving. The objective of these Challenges is to get through the first rounds of proof of concept, and to learn as much as possible along the way, and to increase public awareness of the technical and human possibilities.

Getting to *drive virtually anywhere* obviously involves a significant set of technical challenges. Getting to DVA is going to be a multi-year project, but the major milestones are fairly well identified. Major objectives in the first years will center around understanding non-visual DVIs that integrate information (input) and facilitate control (output) in sufficient detail in real time. We expect that some of the development of underlying technology components, particularly those related to safety, will make major advances without our efforts, but will benefit from the early exposure that we can provide.

In the long run, the hardest challenge will be changing the public's expectations. If we had a blind-drivable vehicle today that was as safe to drive as the average vehicle with the average sighted driver, blind people wouldn't be allowed to drive it, because the blind person would be assumed to be responsible for any accidents that might occur. Starting a significant but appropriately framed public-awareness campaign early will cut years off the time needed to gain the needed level of acceptance to use the technology that will be coming.

1.2 General contest structure

Contestant vehicle and software construction may commence at any time.

There will be a kickoff event on June 30th, 2005. This will primarily be a press opportunity with three goals: a) explain the purpose of the event to the general public, b) solicit new teams, c) announce early sign-ups.

Teams will have until October 30th 2005 to register, and then will be required to submit additional team information by November 15th, 2005.

Registered teams that meet multidisciplinary requirements may then request assistance with solicitations of sponsorship from potential sponsors that have been identified by teams. The primary goal is to verify team legitimacy and encourage sponsorship broadly. NFB will not be identifying potential team sponsors, and will not favor one team over another.

Teams will be required to submit vehicle specifications and mapping and navigation software specifications by January 2nd, 2006.

Teams must submit videos demonstrating that their vehicles meet minimal functionality requirements by March 18th, 2006. At NFBs option, selected teams may be asked to submit to site visits for verification purposes (occurring between March 27th and April 7th, 2006).

Finalists will be selected based on the strength of submitted specifications, videos, and site visits. Qualifying teams will be announced on April 13th, 2006.

The competition will begin with 3D mapping of the task area. Contestants will be given a reasonable amount of time (perhaps a week -- speed of mapping in advance of driving is not considered a limiting factor at this juncture) to map the test areas and ask any relevant questions. All relevant conventional traffic controls will be determined at that time.

There will be two sets of events, on two consecutive days. Technical Challenges on the first day will focus on individual driving skills and vehicle components, as well as mapping and navigation software. The top performers in the Technical Challenges events will be allowed to compete in the Opening Challenge. The Open Challenge will

be a single event on the second day (or the day after the Technical Challenges have been completed) that integrates all of the previous driving skills in a more realistic real-world driving format.

What if things take too long? One primary concern is that there may be too many qualifying teams at any stage.

1.3 Contest Dates

The *NFB Blind Driver Challenge 2006 Event – Ghost Town 1* will be held on September 18th and 19th, 2006. If the Challenge Event cannot be started on the scheduled days, they will be run on the next available day, but no later than September 22nd, 2006.

1.4 Location of the Events

The location of the NFB Blind Driver Challenge 2006 events is to be determined. The event may be held in the southern half of the U.S. to ensure optimal weather, or near Baltimore, Maryland for logistical convenience. NFB will announce the location of the events on May 26, 2006.

1.5 Technical Challenges

Some technical challenges will be related to common driving scenarios (e.g., ability to parallel park), while others may focus on underlying technologies. Some technical capabilities that we will focus on include:

- Mapping accuracy (include the important things, don't include things that shouldn't be there, include sufficient resolution, etc.)
- Real-time positioning accuracy (center vehicle in lane, make turns with appropriate arc, avoid obstacles with sufficient distance)
- DVI control resolution (how close can you get to a curb or parked car)

Some Technical Challenges will be judged based on the performance of certain tasks, which others will be based on subjective ratings of relative merit as determined by a panel of judges. Prizes (listed below) are structured to encourage innovation in several focus areas.

Generally, most tasks for both the Technical Challenges and Open Challenge will be selected from the Task Element list below.

- Call the vehicle on a cell phone to come to you (standing at a curb) from somewhere a couple of blocks away.
- Navigate odd-shaped arterials getting into and out of a large mall parking lot
- Drive through multiple dense residential blocks, including several controlled intersections.
    - Respond to static traffic controls
        - One-way, two-way (and changing?)
        - No parking
        - Stop
        - Speed zone
        - Speed limit (including changes)

        - No U-turn
        - Slower traffic keep right (?)
        - Curves
        - School crossing
        - Railroad crossing
        - Double-yellow lines
    - Left and right turns
    - Do Not Enter
    - Divided roads (shared center turn lane)
    - Divided roads (center island)
    - Marked Crosswalks
    - U-turn
    - Some odd intersection angles
- Goal changes without warning. One of the key goals of this competition is to facilitate creation of DVIs that support third-hand or free-steering control of the vehicle, not just chauffeur-mode driving. This will be tested by changing some task instructions mid-task. More structured parameters will be provided.
- Fast food drive-through
- Parking structure Ticket machines (?)
- Parallel park between parked cars (on level ground)
- Park
    - Park in a large (grocery store or mall) parking lot
        - Find a spot
        - Don't hit things that aren't cars
        - With cars around
        - With no cars (positioning between lines only)
    - In a residential driveway
        - Head-in
        - Back-in
    - on a hill
    - avoid Fire hydrants
    - avoid No Parking areas at appropriately marked times
    - adequate distance from stop signs, intersections
- Roundabouts
    - Several turn options

1.6 Open Challenge

Should we limit participation in the Open Challenge to the winners (1st through 3rd place in any event) of the Technical Challenges? Top scorers based on a total point system?

The Open Challenge is designed to exercise several of the Task Elements listed above, in a cluster of realistic driving scenarios. The Open Challenge will require the driver to make some route-planning decisions in the moment, to emphasize and evaluate driver control at different levels of granularity.

1.6.1 Route Description

The route will be less than 10 miles long, consisting almost entirely of paved surfaces. There will be stationary obstacles of various types, including parked cars, curbs, buildings, posts of various sizes, boxes, paper bags, etc.. Other road variables may include potholes, railroad tracks, puddles, metal plates, flattened cardboard, plastic boxes, chairs of various types, and other typical materials.

1.6.2 Tasks

Tasks for the Open Challenge will be goal-oriented, focusing on routine everyday tasks. Possible examples include (again, feedback would be appreciated):

- Get a hamburger at Burger King
- Go to the grocery store
- Drop of clothes at the cleaners (and parallel park in front of the building)
- Drive from X address to Y address (passing through various traffic controls)

As with the Technical Challenges, tasks will be designed to exercise the Task Elements listed above. A complete task list will be presented at the beginning of the event. The order in which tasks are completed may be counter-balanced across teams so that multiple teams may compete simultaneously but without interfering with one another. Alternatively teams may each complete the sequence of tasks in the same order, with appropriate time-outs for flow control. [Which format would be best?]

1.6.3 Timing

Performance on the Open Challenge will be primarily rated by the amount of time needed to complete each task, and/or on the total time needed to complete the entire set of tasks. Time penalties will be applied for safety or rules infractions.

1.7 Rules

1.7.1 General

The development of revolutionary enabling technologies is a key objective of the Blind Driver Challenge events. Entrants are invited to communicate directly with NFB regarding any rule that restricts their ability to demonstrate technical achievement and innovative solutions to the blind driving problem set.

The Chief Judge has the authority to modify the rules at any time. Reasons for rules modifications include, but are not limited to, the accommodation of promising but unexpected technical approaches that would have been prohibited by the rules and the exclusion of approaches that seek to win without demonstrating the desired technical achievements that are the purpose of the Challenge events. NFB will announce any modifications to the rules with an e-mail to all entrants and a statement on the Grand Challenge website under “Rules”.

The Chief Judge may revise the schedule of the Challenge and provide interpretation of the rules at any time and in any manner that is required. The Chief Judge’s decisions

regarding the rules are based on a number of factors, such as safety, legal compliance, fairness, Challenge goals, environmental protection, and efficient operations. Requests for rules clarifications should be sent to: bdc@nfb.org. NFB will hold confidential any questions that are designated as team proprietary.

Decisions of the Chief Judge are final.

1.8 Prizes

1.8.1 General

The purpose of the prizes is to provide direct incentive for innovation. No contract or other incentive is promised as a result of this Challenge. Tax treatment of the prize will be handled in accordance with US Internal Revenue Service guidelines. The team leader will be required to provide the appropriate US taxpayer identification number for the individual or organization to receive the prize.

1.8.2 Technical Challenges

NFB will award multiple smaller *prizes* with a total value of $X (perhaps the same value of X for the Open Challenge) to the *teams* whose vehicles most effectively complete specific driving tasks and technical challenges.

1.8.3 Open Challenge

NFB will award three *prizes* with a total value of $X to the top three *teams* whose vehicles complete the route with the shortest *corrected times* and complies with all other eligibility requirements.

1.8.4 The Split

1.8.4.1 Technical Challenges

Vehicle Evaluations – Subjective	
Easiest to drive	1st Place
	2nd Place
	3rd Place
Most passable	1st Place
	2nd Place
	3rd Place
Safest overall	1st Place
	2nd Place
	3rd Place
Best driver	1st Place
	2nd Place
	3rd Place

Technical Merit – Subjective	
Most intelligent collision-avoidance system	1st Place
	2nd Place
	3rd Place
Most responsive navigation system	1st Place
	2nd Place
	3rd Place
Most effective route-planning system	1st Place
	2nd Place
	3rd Place
Safest route-planning system (including normal conditions and contingencies)	1st Place
	2nd Place
	3rd Place
Best Technical Paper	1st Place
	2nd Place
	3rd Place

Completion of Basic Driving Tasks -- Objective	
(Overall, based on points for completion, time to complete, subjective merit)	1st Place
	2nd Place
(8-10 Tasks, prizes for each)	3rd Place

Mapping and Navigation Software - - Objective	
Most accurate positioning system	1st Place
	2nd Place
	3rd Place
Most accurate maps (measured position vs. reality)	1st Place
	2nd Place
	3rd Place
Most robust maps (includes semantic details)	1st Place
(subjective?)	2nd Place
	3rd Place

1.8.4.2 Open Challenge

Open Challenge -- $X total	
1st Place	$X
2nd Place	$X
3rd Place	$X

5/3/2?
5/3/1?
4/3/2?

1.9 Blind Driver Challenge 2006 timeline

Table 1 – Application (Eight parts)		
Required Submittal	***Delivery Method***	***Deadline***
Part 0 – Kickoff event (attendance encouraged but not required)		June 30, 2005
Part 1 – Team Information and registration fee submitted	Email	October 30, 2005
Part 2 – Additional Information	Postal mail	November 15, 2005
Part 3 – Requests for assistance with solicitation of sponsors	Email	January 2, 2006
Part 4 – Vehicle Specification	Email	January 2, 2006
Part 5 – Mapping and Navigation software Specification	Email	January 2, 2006
Part 6 – Video demonstration 1 – Driving (interior and exterior)	Postal mail	March 18, 2006
Part 7 – Site Visit Agreement	Postal mail	March 18, 2006
Part 8 – Video demonstration 2 – Mapping and Navigation software	Postal mail	March 18, 2006

Table 2 – Selection and Qualification Process		
Event	***Remarks***	***Date***
Step 1 – Announcement of teams that have registered		December 1, 2005
Step 2 – Announcement of teams who have submitted required specifications		January 15, 2006
Step 3 – Announcement of teams who have submitted required videos		March 24th, 2006
Step 4 – Announcement of teams approved or selected for site visits	Results from review of vehicle and mapping software specifications, and review of video demonstrations	March 24th, 2006
Step 5 – Site Visits	Conducted by NFB representatives	March 27 – April 7, 2006
Step 6 – Announcement of teams selected to participate in the Challenge events	Based on results from review of specs, video demos, and site visits	April 13, 2006
Step 7 – Technical papers submitted	Required from all finalists. Submit via email.	May 26, 2006
Step 8 – Announcement of Challenge locations (city)	City location only, for planning travel	May 26, 2006
Step 9 – Announcement of Challenge routes	Mapping may begin at 8:00 AM and continue until 5:00 PM September 16th. Unimpeded access not guaranteed.	September 8, 2006
Step 10 – Meeting with all finalist team leaders	Mandatory attendance	September 17, 2006
Step 11 – Technical Challenge events	All qualifying teams participate	September 18, 2006
Step 12 – Open Challenge event	Technical Challenge top scorers participate	September 19, 2006

2 Eligibility

2.1 Team membership

A team is comprised of the individuals identified to NFB on the team roster. Only these individuals are *team members.* Each team must designate a single individual to serve as the team leader. The team leader must be at least 21 years of age on the date of application to the Grand Challenge. U.S. citizenship is not required.

For each team, the team leader will serve as the primary point of contact with NFB. The team leader must sign the application, must provide a notarized signature on the *Certification of Team Funding and Support* and *Site Visit Liability Statement,* and must be present at the site visit and the Challenge Events. The team leader will specify the team members and will determine the disposition of the prize should the team be successful. An individual may be the leader of only one team but team members may serve on multiple teams.

Team leadership may be transferred from the team leader to another eligible individual; there may be only one team leader at any time. Transfer of team leadership occurs when NFB receives a notarized *Change of Team Leader* form. The form is available from NFB and must be signed by the existing team leader and the new team leader. The new team leader must also submit a notarized Part 2B (Certification of Team Funding and Support), and a notarized Part 5B (Site Visit Liability Statement).

Although the number of individuals listed on the team roster is not expressly limited, NFB will impose a limit on the number of team members allowed into designated areas at the Challenge Events. NFB will communicate the limit to the team leaders upon notification of selection.

2.2 Multi-disciplinary teams

Teams that include experts (defined as an active team member holding a Master's degree or higher in the related field) from each of the following areas of expertise will qualify as being "multi-disciplinary" and will receive additional NFB assistance with solicitation of sponsorship from team-identified potential sponsors:

- Human Factors or Computer-Human Interaction (or substantially similar)
- Computer Science or Computer Information Technology (or substantially similar)
- Mechanical Engineering or Electrical Engineering (or substantially similar)

NFB assistance will primarily be in the form of reassurance to the potential sponsors that NFB believes that the multi-disciplinary team has a fair chance of meeting the full qualification requirements and competing as a finalist in the Contest Events.

Our objectives in including this selective incentive are:

1. To encourage participation of highly qualified professional in the vehicle, software, and DVI design process.
2. To encourage cooperation between potentially distributed specialized sub-teams that focus on individual components rather than the entire vehicle.
3. To provide unbiased assistance to a manageable number of teams.

2.3 Non-US Participation and Sponsorship

Individuals holding foreign citizenship are eligible to participate in the Challenge on teams in any role, including team leader. Foreign corporations and non-governmental organizations may participate as *team sponsors.* Teams receiving funding or any form of

support from foreign *governments* or foreign governmental organizations *are* eligible to participate.

2.4 Government Organization Participation

US and foreign government organizations and agencies are eligible to participate.

2.5 Team Funding and Support

The cost of developing, fielding, and insuring entered vehicles is the sole responsibility of the individual teams. NFB will not provide funding for the purpose of Grand Challenge entry or participation.

2.6 [Intellectual Property licensing Provisions]

At the Seminar we discussed including a requirement to provide cost-free licensing of included technologies for short periods (5-8 years?), to facilitate faster evolution of underlying components over several engineering/test cycles. I'd like to get more feedback on this from potential participants.

3 Challenge Vehicle Requirements

3.1 Variable Autonomy and Variable Control

Vehicles should empower the driver with sufficient control such that the driver will be able to steer the vehicle and control throttle and braking with realistic fidelity in real time. Realistic fidelity means with a degree of control sufficient to enable easy interaction with a highly dynamic environment without unduly hindering or inconveniencing other drivers or pedestrians. The vehicle should ideally never be doing something other than what the driver wanted it to do.

Enabling this degree of control does not necessarily mean eliminating all "automation". We suspect that there may be strong practical utility in having a "third hand" mode that provides intelligent assistance automatically in some typical driving scenarios. For example, it may make most sense to have vehicles follow an invisible path on most roads. Following the path alleviates the tedious task of lane-maintenance. In this theoretical (but not required) "third-hand" mode, if the driver takes his hands off the wheel, the car will drift back to following the invisible path automatically. Third hand mode may or may not preclude "free-steering" in the moment. How these and other potential driving modes, invoking different levels of vehicle autonomy and intelligent assistance, can be enabled for and controlled by the driver is high on our list of DVI usability questions.

Teams should assume that some contest tasks will require a very high degree of in-the-moment control fidelity, while others will require less fidelity.

We suspect that implementing the underlying systems necessary to impart free-steering or third-hand (steering and speed-assisted) control modes will also enable an even more automatically-assisted "chauffeur" mode. Though we believe that chauffeur mode will be a popular option with many (but not all) sighted drivers as well as blind drivers, it is

not our primary intention to evaluate the usability of chauffeur mode in these Challenges. The reason is that with many people in the general public there is already a strong bias toward thinking that only a fully-effective chauffeur mode will be sufficient to enable blind people to drive, and that nothing more should be expected from a blind driver, and that blind driving should not even be considered until that level of technological advancement has been attained. We are confident that all of these points are incorrect, and are eager to dispel these myths.

3.2 Vehicle Limitations

3.2.1 General

The entry must be a street-legal two-axel ground vehicle that is propelled and steered principally by traction with the ground. The vehicle must not damage the environment or infrastructure along the Challenge route. Vehicle operation must conform to any regulations or restrictions imposed by the applicable land-use authority. The vehicle must be able to travel on asphalt pavement without damaging the pavement surface.

3.2.2 Size, Weight

The goal is to keep vehicles street-legal. Keep in mind long-term goal of safety implies noticability and impact on other cars in accidents. Humvees OK, no bigger (with sensors). What actual dimensions?

3.2.3 Sighted-Drivable

The vehicle should be configured such that a sighted person sitting in one of the front seats could take control and drive with conventional controls (steering wheel, brakes, accelerator) at a moment's notice. Right- or left-side sighted control is not an issue at this time, but we suspect there may be some long-term value in having blind people drive from the right side in the US, so that a license sighted person may act as the nominal driver during training and such.

3.3 Classified Data and Devices

We need to work this out regarding intellectual property restrictions. I don't mind allowing classified technology in principle, but compelling a degree of sharing may be of more benefit.

3.4 Tethered Vehicle Systems

Only individual, independent, untethered ground vehicles are eligible to participate in the Blind Driver Challenge.

3.5 Vehicle Identification Number

Each contestant team will be assigned a unique identification number that shall be displayed on its vehicle at least 12 inches in height on its sides, front, back, and top. The number should be either black or white and have a solid background that extends at least 3 inches larger than the number. The color of the background should contrast with the number such that the number is clearly visible and distinguishable from other signage or

symbols on the vehicle. Teams are allowed to obtain sponsorships and to display advertising if the NFB Officials do not consider such advertisements inappropriate. The NFB Blind Driver Challenge 2006 logo may be displayed on each vehicle.

3.6 Vehicle Safety

NFB makes no representation as to the safety of any vehicle entered in the Challenge notwithstanding any rule or the acceptance by NFB of any application document, *vehicle specification sheet*, video demonstration, or any inspection or demonstration required as a condition of participating in the Challenge.

3.6.1 Radiated Energy Safety Standards

3.6.1.1 Laser Safety Standards

All parties are directed to OSHA 29 CFR 1926.54 and OSHA Technical Manual (TED 1-0.15A), Section III - Chapter 6 (1999, January 20) for relevant laser safety standards. Challenge vehicles must comply with all applicable local, state, and federal laser safety regulations.

3.6.1.2 RF Radiation Standards

All parties are directed to OSHA 29 CFR 1910.97 (Non-ionizing Radiation) and Department of Defense Instruction 6055.11 (1995, February 21) for relevant RF safety standards. All Challenge vehicles must comply with all applicable local, state, and federal RF safety regulations.

3.6.1.3 Acoustic Safety Standards

All parties are directed to OSHA 29 CFR 1910.95 (Occupational Noise Control) and OSHA Technical Manual (TED 1-0.15A), Section III - Chapter 5 (1999, January 20) for relevant acoustic safety standards. All Challenge vehicles must comply with all applicable local, state, and federal acoustic safety regulations.

3.6.2 Wireless Emergency Stop (E-stop) Units

Can we use the DGC e-stop devices? This would save a lot of redundant effort. Perhaps something plug-compatible?

3.6.3 Visual Warning–Vehicle Brake

Each vehicle shall display two or more steadily illuminated red warning lights on the rear of the vehicle and visible within a 90-degree cone that illuminates when, and only when, the vehicle's dynamic braking system (not the parking brake) is activated. The purpose of this light is to indicate that the vehicle is braking. The placement of this light should be mounted high and sufficiently distant from the flashing amber warning lights to permit rapid recognition.

3.6.4 Visual Warning–Blind Driver

We need to decide whether to disallow or restrict use of visual warnings designed to alert other non-contestant drivers and pedestrians to the fact that the contestant driver is blind.

This may not be relevant until we get to the Master Blind Driving Challenge, but we should get the message straight now.

3.7 Towing Requirements

Each vehicle must be designed to facilitate removal from the route should the vehicle be disabled. The vehicle must have tow points front and rear, or if the vehicle design precludes towing, the vehicle must have hoist points. Wheeled or tracked vehicles must have a free-wheel mechanism that enables the wheels or tracks to spin freely in order to enable towing. The free-wheel mechanism must be readily accessible and clearly marked.

3.8 Position Determination Signals

Challenge vehicles may be equipped to receive and process electronic position-determination signals (such as GPS) that are openly or commercially available to all teams. Position-determination signals that are neither openly available nor commercially available to all teams are prohibited.

3.9 Wireless Signal Restrictions

All computing, intelligence, and sensor processing must be contained onboard the vehicle while on the Challenge route. Apart from the control and tracking signals from NFB-provided systems and openly or commercially available navigation signals, the emission or reception of communication signals is prohibited. On-board wireless connections are prohibited. A vehicle may emit and receive signals to sense the environment. Vehicles may record video or other data on-board for review after the conclusion of the event. Any data recorded on the course route may not be shared among teams until the conclusion of the Challenge event. Any data recorded during the Challenge Event may not be shared among teams until all vehicles have finished the route or have been disqualified. Any wireless system used for vehicle movement or testing must be disconnected prior to the departure signal at the Challenge Event. The wireless hardware must be easily accessible and capable of being inspected. This includes systems for monitoring, control, or intra-vehicle communication.

3.10 Video

All vehicles will be required to include mounted cameras to record the following for later review:

- Steering
- Acceleration
- Braking
- Driver's head (showing sleep shades in place)

Video should be recorded in at least NTSC resolution, with at least 15 frames per second.

3.11 Vehicle Cooperation

Cooperation of any kind among vehicles on the Challenge Event route is prohibited.

3.12 Environmental Impact

Any aspect of vehicle activity or operation that has an unacceptable impact on the environment is prohibited. These activities include destructive vehicle behavior, the use of abnormally hazardous substances or materials, and generally reckless operation. Potentially hazardous equipment or activities must be identified to NFB for review in the vehicle specification sheet.

3.13 Pre-Challenge Testing

Testing of Challenge vehicles or components is the sole responsibility of each team. The use of public lands for this purpose is at the team's own risk and must be in accordance with applicable local, state, and Federal guidelines.

4 Application Procedure

4.1 Basic Requirements

Applications will be accepted beginning June 30th, 2005. There is a $500 fee for entry. World Wide Web access, e-mail access, and basic word processing are necessary to complete and submit the application and for communication with the NFB Blind Driver Challenge staff.

The application consists of five parts:

- Part 1: Team Information
- Part 2: Additional Information and Certification of Team Funding and Support
- Part 3: Vehicle Specification Sheet
- Part 4: Video Demonstration
- Part 5: Site Visit Agreement

Instructions for obtaining Blind Driver Challenge application materials and for proper submission are on the Blind Driver Challenge website. All parts of the application must be received at NFB before the specified deadlines for a team to become eligible for participation in the Blind Driver Challenge. Materials received after their respective deadlines will not be considered, and will be destroyed by NFB. Application Part 1 must be received by NFB no later than 5:00 PM EST on October 30, 2005. Application Part 2 must be received by NFB no later than 5:00 PM EST on November 15, 2005. Application Parts 3, 4, and 5 must be received by NFB no later than 5:00 PM EST on January 30, 2006.

4.2 Submission Procedures

Application documents must be submitted using the transmittal instructions on the forms. The receipt of application documents will be promptly acknowledged by NFB. Delivery information and official time of receipt will be recorded as follows: Application materials remitted using US Postal Service, courier, or overnight delivery service should be addressed to:

NFB Jernigan Institute

Attn: Blind Driver Challenge
1800 Johnson Street
Baltimore, MD 21230

The time of receipt for each package will be logged as recorded in the NFB mailroom.

E-mailed application materials should be addressed to: bdc@nfb.org.

The time of receipt for each document will be logged by the NFB e-mail system.

4.3 Additional Materials

NFB may request additional information from the teams after the receipt of the application materials. Examples of additional required information include an updated team roster, photographs of the Challenge vehicle, and a photograph of the team.

4.4 Team Promotional Materials

Contact information for each team including team leader name, team e-mail address, and team URL will be posted on the Blind Driver Challenge website to enable contact from potential sponsors, other teams, and media. Promotional materials provided by the teams such as the team description paragraph, team sponsor list, team picture and vehicle picture will also be published on the website. Following the conclusion of the Blind Driver Challenge Events, team technical papers will also be published on the website.

4.5 Sponsorship References

Teams that meet multi-disciplinary diversity requirements (TBD – essentially we want to get representatives from relevant disciplines such as human factors, CS, EE, ME, etc. on each team) will be given non-preferential assistance in securing team sponsorship. Essentially what we'll do is make a limited number of phone calls to say, "we think this team has what it takes to accomplish this worthy challenge, and we hope you'll support them."

Would it be useful to offer a higher degree of assistance (press coverage, etc.) to teams that satisfy certain technical thresholds – the top-tier competitors?

5 Qualification Process

5.1 Overview

Teams that wish to compete in the Blind Driver Challenge Event must complete all steps of the qualification process. A team that has submitted parts 1 and 2 of the application by the respective deadlines and has received acknowledgement from NFB becomes a Blind Driver Challenge entrant. A team must submit parts 3, 4, and 5 of the application by the deadline in order to remain an entrant. A team that submits parts 6, 7, and 8 (videos and site visit agreement) of the application by the deadline becomes a semi-finalist. Based on video and site visit results, up to ten semi-finalists teams will be selected for the Blind Driver Challenge Event, where they become finalists.

5.2 Videos

The primary method by which NFB will determine a team's eligibility to compete in the Blind Driver Challenge events will be on the merits of the component functionality (vehicle, DVI, mapping software, navigation software). Teams will be asked to demonstrate this functionality and record it on video for review by NFB.

5.3 Selection for Site Visit

NFB will review each team's video demonstrations and vehicle specification sheet submitted as part of the application. Applications will be evaluated on the basis of:

- Conformance with the rules
- Possession of a vehicle
- Possession of sensor equipment
- Possession of navigation equipment
- Possession of non-visual DVI equipment
- Possession of mapping software
- Possession of navigation and control software
- Capability of vehicle to complete the Blind Driver Challenge Event route
- Demonstration of
    - Mapping
    - Navigation
    - Sensor capabilities
    - DVI robustness

  necessary for completion of the Blind Driver Challenge.

Instructions for the Video and the vehicle specification sheet are provided on the application form available on the BDC website. On January 6, 2006, selected entrants will be notified of NFB's intent to conduct a site visit. On February 3, 2006, NFB will notify all teams of the results of the review process based on the vehicle specification sheet, video demonstrations, and site visits.

5.4 Site Visit Procedure

Site visits are intended to verify the same criteria that might possibly be verified with the video submissions.

5.5 Technical Papers

A technical paper describing the architecture of the vehicle and accompanying software of each finalist must be received at NFB by February 20, 2006. A description of the subjects that must be addressed in the technical paper will be available on the Blind Driver Challenge website by November 4, 2005. NFB will withhold the technical papers until the conclusion of Blind Driver Challenge 2006, at which time the papers will be made available to the public.

Are there concerns from potential government contestants that technical papers might require disclosure of too much information?

Other than the required technical paper and information already in the public domain, NFB will not publicly release information regarding a team's technical approach without permission from the team leader.

[Need to settle intellectual property (IP) rights from entrants, semifinalists, finalists, or the winner.]

6 Blind Driver Challenge Events

6.1 General

6.1.1 Blind Driving

During contest events, all drivers will be required (even if the driver has no usable vision) to wear "sleep shades" provided by NFB that block all light from the eyes. Removal of sleep shades during the event will be grounds for disqualification.

6.1.2 Vehicle Control

The vehicle should be under the control of the driver at all times. The driver should be able to stop the vehicle at any time. The driver should be able to steer the vehicle with a normal range of control at any time.

6.1.3 Obstacles

The vehicle must avoid collisions with any static obstacles on the route. NFB will place obstacles along the route to test obstacle avoidance capabilities. Vehicles that collide with any other vehicle or obstacle along the route may be disqualified or penalized. Incidental or non-damaging contact with obstacles may not result in disqualification, but may result in penalties.

6.1.4 Intentional Interference and Damage

Intentional interference with other vehicles is prohibited. Intentional interference is any activity that, in the opinion of the Chief Judge, is intended to degrade another vehicle's ability to compete. Any team responsible for the intentional damage of property that does not belong to that team may be disqualified. Intentional damage includes damage that occurs as a result of failure to prevent damage that could have been foreseen and includes damage that adversely and materially affects the performance of another team. The Chief Judge will have the final say in all matters involving damage.

6.1.5 Jettisoning Material on the Route

Except for normal byproducts of power generation, the intentional jettison of any material from a vehicle is prohibited and may result in disqualification. If a portion of a vehicle unintentionally falls from the vehicle while on the route, NFB will notify that team, and the team is responsible to recover such debris once all qualified vehicles have cleared the affected area. A smokescreen or any other obscurant intentionally discharged from a vehicle is specifically prohibited.

6.1.6 Disqualification

A disqualified vehicle may not continue on the route. NFB will coordinate with the driver and team to remove the vehicle from the route. Teams will enter the route area only when so directed by NFB officials.

6.2 Technical Challenges

6.2.1 General

6.2.2 Tasks

6.2.3 Task Sequence

6.2.4 Scoring

6.2.5 Announcement of Winners and Qualifiers for the Open Challenge

6.3 Open Challenge

6.3.1 General

6.3.2 Departure Area

6.3.3 Tasks

6.3.4 Scoring

6.3.5 Announcement of Winners

7 Appendix: Definitions