



CS/EE/ME 75 – Team Caltech 2 October 2006



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12:00-12:05

Meeting Goals and Agenda

Goals

- Review the course project (Urban Challenge) and project/class structure
- Describe how technology will be inserted into our system (using TRLs)

Agenda

12:00 Goals, Agenda, Notetaker
12:05 Course overview
12:10 Urban Challenge
12:30 Technology insertion process
12:45 Course administration
1:00 Adjourn

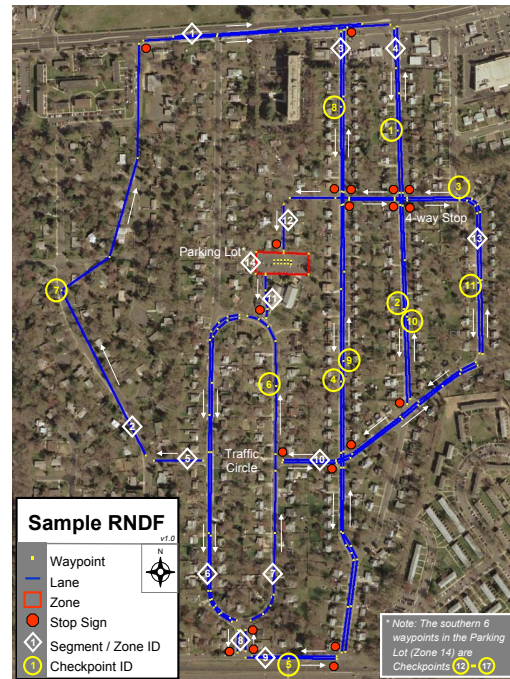
Notetaker: _____

- Record notes and action items from meeting; post on wiki

2007 DARPA Grand Challenge (Urban Challenge)

Autonomous Urban Driving

- 60 mile course, less than 6 hours
- City streets, obeying traffic rules
- Follow cars, maintain safe distance
- Pull around stopped, moving vehicles
- Stop and go through intersections
- Navigate in parking lots (w/ other cars)
- U turns, traffic merges, replanning
- Prizes: \$2M, \$500K, \$250K



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Urban Driving



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Basic Navigation

DARPA GRAND CHALLENGE Basic Navigation

Vehicle stays entirely within travel lane around corners.

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DARPA GRAND CHALLENGE Basic Navigation

Vehicle exhibits less than 10 seconds of delay when intersection is clear.

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DARPA GRAND CHALLENGE Basic Navigation

Vehicle stops within 1 meter of stop line.

Front bumper of vehicle must be in this zone during stop

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DARPA GRAND CHALLENGE Basic Navigation (selected)

Vehicle completes passing maneuver in 40-meters or less maintaining 8-meter safety buffer

vehicle entirely within passing lane

stopped vehicle

vehicle leaves lane

vehicle entirely back in lane

40m

8m

8m

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Basic Traffic

DARPA GRAND CHALLENGE Basic Traffic

Vehicle maintains 15 meter safety buffer at 15 mph.

between 15 and 40 meters

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DARPA GRAND CHALLENGE Basic Traffic

Vehicle stops between 5 and 10 meters behind stopped lead vehicle.

between 5 and 10 meters

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DARPA GRAND CHALLENGE Basic Traffic

Vehicle exhibits correct precedence order at intersection.

precedence at intersection

proper queuing behavior at stop sign

safe following distance (15m at 15mph)

First to reach stop line is the first to leave.

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Advanced Navigation

DARPA GRAND CHALLENGE **Advanced Navigation**

A U-turn may be effected through one or more three-point turns.

● Waypoint
● Entry waypoint
● Exit waypoint

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DARPA GRAND CHALLENGE **Advanced Navigation**

Vehicle re-plans when primary route is blocked.

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DARPA GRAND CHALLENGE **Advanced Navigation**

Vehicle exhibits correct parking lot behavior with less than 10 seconds excess delay.

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DARPA GRAND CHALLENGE **Advanced Navigation**

Road-following situations

- Curbs, berms, vegetation
- Street lines may be missing
- Winding roads
- Sparse waypoints - may not be in center of road

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Advanced Traffic

DARPA GRAND CHALLENGE **Advanced Traffic**

- Vehicle should pull into traffic when oncoming vehicles leave a gap of at least 10 seconds.

- Vehicle maintains 8 meter safety gap.

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DARPA GRAND CHALLENGE **Advanced Traffic**

Vehicle makes a left turn across moving traffic and proceeds with less than 10 seconds excess delay.

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DARPA GRAND CHALLENGE **Advanced Traffic**

Vehicle navigates parking area in the presence of moving traffic

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DARPA GRAND CHALLENGE **Advanced Traffic**

Vehicle exhibits safe behavior at all times to avoid collisions and near collisions.

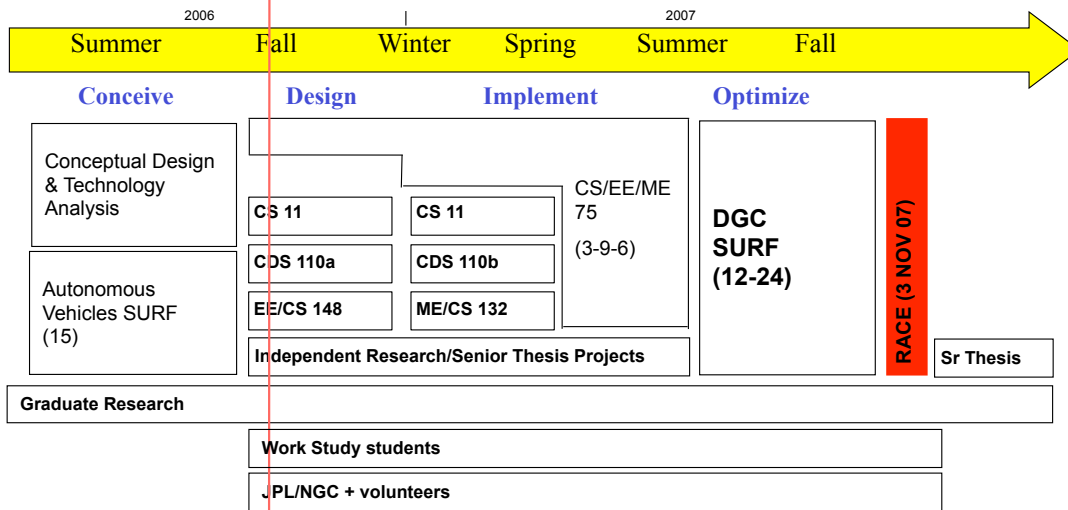
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NORTHROP GRUMMAN

Team Caltech, 2006-07

Goal: design, build and document an autonomous ground vehicle that can win the 2007 Urban Challenge



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Technology Readiness Levels

TRL	Description	Entry Criteria
1	Technology concept - Review of literature shows technology concept is available & potentially useful	Documented on wiki or bugzilla
2	GOTChA chart has been developed for the project indicating how a given technology might be applied	GOTChA chart posted on wiki
3	Desktop demo - demonstration of the key ideas is available via a hardware mockup or MATLAB demo	Preliminary design and demo posted on wiki
4	Prototype implementation - documented initial demo of the technology that verifies key objectives	Documented design with external review
5	Alice demonstration - demo of the technology on Alice (or using logged data); not yet baseline code	Demonstration on Alice
6	Reviewed design - successfully pass design review, including implementation in standard code/hardware base on Alice documentation on wiki and doxygen	Pass formal design review
7	Integrated module - integrated into standard code/hardware base; tracked w/ config mgmt process	Build manager/implementation team signoff
8	Flight tested - demonstrated in an Integrated Test Team (ITT) sponsored test	Documented performance in ITT test
9	Race ready - tested for 100+ hours of operations in a race-like environment.	Documented operation for 100+ hours

- SURF06
- CEM 75ab
- CDS 110+
- EE 148+
- ME 131+
- ...

- CEM 75c
- Indep proj

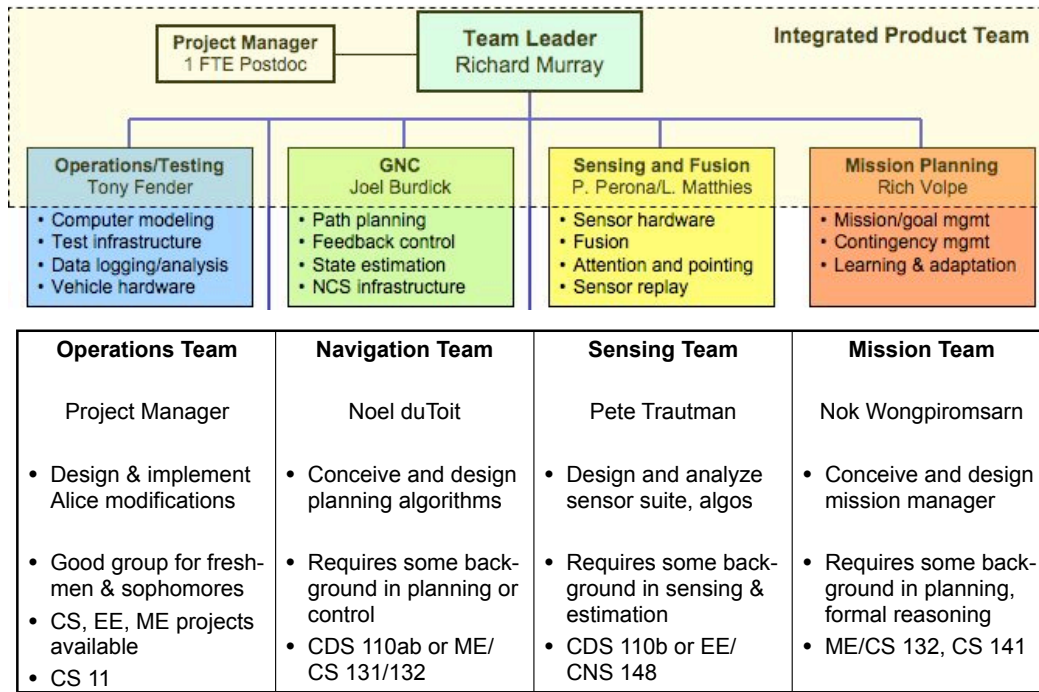
- Implementation team
- SURF07

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Team Caltech Organization: Race Teams



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Team/Project Signup

Homework Set #1

- Read through the project rules, to get a better sense of what we have to do
- Read through JFR paper, to understand how Alice currently works
- Select three projects you are interested in, and evaluate the TRL levels

Next week

- Team coordinators will summarize what was done over the summer and open design questions/tradeoffs
- Everyone will select a team and find a time that works for weekly team meetings
- At first team meeting, initial project assignments will be made (teams of 1-3)

Remainder of the term

- Project meetings and homework: learn about collaboration concepts and tools
- Team meetings: work through trade studies and track project progress
- Team presentations (weeks 6-9): present status of team activities
- Finals: TRL 4 design review for projects (linked course or small project)

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Course Administration

Class homepage: <http://www.cds.caltech.edu/~murray/cem75>

- Username: TeamCaltech
- Password: _____

Course meetings

- Project meetings: Mondays, 12-1 pm (1 hr, weekly)
- Team meetings: TBD (weekly)

Grading

- 20% Homework (weeks 2–5 only)
- 20% Team presentations (weeks 6-9)
- 20% Participation (attendance, discussion, contributions)
- 40% Documentation of work for the term
 - Linked course: write up project results for TRL 4/5 evaluation
 - No linked course: write up work on small team project (TRL 5/6)

Collaboration policy: full collaboration encouraged. Write up your own work.