

01. Introduction & Logistics

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Lecture material and readings are posted at
<http://www.ece.cmu.edu/~ece848d>

Overview of Lecture

- ◆ Logistics
- ◆ Grading criteria
- ◆ Policies
- ◆ Introduction to the course
- ◆ Course support: TA, office hours, mailing list
- ◆ Schedule of lectures
- ◆ Schedule of project milestones
- ◆ Expectations on both sides

Welcome to 18-848d

- ◆ Special topics course in embedded systems
 - ▶ Focus on sports technology
- ◆ Builds on the fundamentals that you have acquired elsewhere
 - ▶ *18-348: Embedded System Engineering*
 - 8/16-bit microcontroller course
 - ▶ *18-349: Embedded Real-Time Systems*
 - 16/32/64-bit microprocessor course with real-time operating system
- ◆ This is first time that this course is being offered
- ◆ Primary focus on a single sizable project all semester long
- ◆ Good news
 - ▶ Yes, you will need to build something that works!
 - ▶ Yes, you get to propose the project that you want to do
 - ▶ Teams will end up doing different projects, in all likelihood



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Featuring Yours Truly

- ◆ What I enjoy in research
 - ▶ Research: Sports technology
 - ▶ Several research projects within my group focused on different aspects of sports
 - ▶ Spun off a CMU company to develop live mobile streaming for sports
 - Real-world experience in building and selling sports technology
- ◆ What I enjoy in teaching
 - ▶ *18-349: Embedded Real-Time Systems* (Fall 2007 onwards, and previously, Fall 2005, Fall 2003, Fall 2002) – next time, Fall 2010
 - ▶ *18-549: Embedded Systems Design*, capstone course (Spring 2007, Spring 2008, Spring 2009) – next time, Spring 2010
 - ▶ *18-749: Fault-Tolerant Distributed Systems* (previously offered in Spring 2006, Spring 2005, Spring 2004, Spring 2003) – not currently being offered

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Administrivia

- ◆ Course mailing list for *all* discussions and announcements
 - ▶ 18-848d@lists.andrew.cmu.edu (you should be subscribed already)
 - ▶ If not, please subscribe at <https://lists.andrew.cmu.edu/mailman/listinfo/18-848d>
- ◆ TAs
 - ▶ Shahriyar Amini, Mark Ma
 - ▶ Students whom I work with and who have embedded/mobile experience
- ◆ Lectures
 - ▶ Mondays & Wednesdays, 2.30-4.20pm, INI DEC
- ◆ Textbooks – None!
 - ▶ Unique course, first-time offering at Carnegie Mellon
 - ▶ Not taught in any university
 - ▶ You will leave this course understanding (through first-hand experience) the skills, critical thinking and trade-offs in sports technology
- ◆ All necessary readings and handouts will be given in class and/or available online on <http://www.ece.cmu.edu/~ece848d>

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Office Hours

- ◆ Office hours for instructor
 - ▶ Mondays & Wednesdays, 1 hour after the lecture in the classroom
 - ▶ Design review meetings with me from time to time (CIC 2202)
 - Go over project status, difficulties, next steps, challenges, resources needed
- ◆ You can reach me multiple ways, most preferred to least preferred
 - ▶ Email: priya@cs.cmu.edu
 - ▶ IM: narasimhan.priya@gmail.com
 - ▶ Twitter: priyacmu (DM me if it's related to the course)
 - ▶ Phone: 4122688801 (forwards to my cellphone)



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Getting Help

- ◆ I expect an “average” CMU student will put in 12 hours/week
- ◆ If you start to see yourself exceed the number of hours greatly, then,
 - ▶ You might need additional background knowledge
 - ▶ You might be approaching the project the wrong way
 - ▶ Your project might not be well-scoped or well-defined
 - ▶ Your test-bed might not be appropriate
- ◆ Specific things I want to know about as soon as you face them
 - ▶ Being overwhelmed by the course material or the pace of the course
 - ▶ Hardware or software issues in project implementation
 - ▶ Problems with TA/instructor support or staffing
- ◆ I want to know **immediately** – please come and talk to me!
 - ▶ I want to see this course improve and flourish for many semesters to come
 - ▶ Let me know what we’re doing right and what we’re doing wrong



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Classroom Protocol

- ◆ “Showing up is 80% of life.” [Woody Allen]
- ◆ Please arrive on time; lecture begins promptly
 - ▶ We also promise to end on time
 - ▶ Handouts posted on course website before the lecture (for most lectures)
 - ▶ Please print handouts before coming to class (if you see handouts)
- ◆ Questions are encouraged
 - ▶ If you don’t understand, ask, because probably other students are struggling too
 - If you don’t understand during class, you’re unlikely to figure it out later
- ◆ There is no way to cover everything
 - ▶ If there is an interesting aspect (e.g., physics of baseball) that we do not cover in class, feel free to incorporate it in your projects
 - ▶ I am happy to encourage projects that push the envelope, as long as you build a sports technology that is interesting, challenging and has value

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Overview of the Course

- ◆ Hands-on emphasis needed to acquire sports technology skills
- ◆ *Semester-long* team project to design and build a working sports technology

Course Organization

- ◆ NO lab exercises (you've already had these in 18-348 or 18-349)
- ◆ NO mid-term exam
- ◆ NO final exam
- ◆ Readings on specific topics related to sports technology
 - ▶ You get to pick which topic and which 2-3 papers relate to the topic
 - ▶ You will present this topic in class individually
- ◆ Project – team-based and focus of the course
 - ▶ Most of your time will probably be spent on the project and in the lab
 - ▶ Well-paced minor milestones every two weeks – *we will start right away!*
 - ▶ Phases of the project – concept, requirements, procurement, architecture, design, debugging, testing, measurement, prototyping
 - ▶ Mid-semester demo and a final demo
- ◆ Lectures and readings geared towards project and its milestones

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Lecture Content (1)

- ◆ This is a course where it is tremendously important to be plugged into industrial practices and the state-of-the-art
 - ▶ You need to understand what works and what doesn't in the sports industry
- ◆ Guest speakers
 - ▶ We expect to have guest speakers from the sports industry
 - Fox Sports Network, Pittsburgh Penguins management, Wilson Football, Intel Labs, Cisco's Sports & Entertainment group, etc.
 - ▶ Covering various aspects
 - Sports business, physics of sports, broadcast production, coaching, training
- ◆ Tours of sports facilities
 - ▶ We will try to organize tours of Heinz Field, PNC Park, Mellon Arena and the new Consol Energy Center, as well as the UPMC Sports Medicine Complex
 - ▶ Purpose is to get a behind-the-scenes tour of sports facilities
 - Example: How is the jumbotron videoboard managed?

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Lecture Content (2)

- ◆ YOU are going to create additional lecture content

- ◆ We have a range of sports technology topics
 - ▶ Broadcast technologies, video analysis (includes game-film breakdown), scouting, training, video games, performance and rehab, motion capture, statistics
 - ▶ We will provide starting points (1-2 papers) for each of these topics

- ◆ You will be responsible for
 - ▶ Picking a topic and signing up for the time-slot to present
 - ▶ Picking 2-3 papers on the topic, coordinating with the other students presenting that day – there will be 6-9 papers covered per lecture by the 4 students
 - ▶ Preparing a 20-minute talk (including Q&A) on the topic on the papers you selected
 - Include state-of-the-art (industrial practice) and state-of-research (what is still to be developed, and being worked on in academia)

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Schedule Flexibility

- ◆ We are at the mercy of
 - ▶ Sports facilities – they can close suddenly for repairs, for events (concerts get announced outside my control)
 - ▶ Guest speakers and their schedules

- ◆ We want to have these opportunities
 - ▶ We've tried very hard to make sure that we can provide a unique course
 - ▶ The trade-off: I can't always control the schedule, no matter how hard I try

- ◆ My sincere request – *please*
 - ▶ Have patience if a guest speaker cancels
 - ▶ Have patience if we need to move a guest-speaker or tour time-slot
 - ▶ Have patience if we have to schedule a facility tour outside of class times
 - You are expected to be at all lectures, anyway, so this should not be a problem ☺
 - Hopefully, you will have your lecture ready a week in advance so that you can be ready to go past that point

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Course Organization

- ◆ Everything will be electronic, posted to class website
 - ▶ All handouts will be posted electronically
 - Exceptions: Guest speakers might not allow us to (sometimes, companies have sensitive documents/images that we won't have access to)
 - ▶ All schedule changes will be posted there
- ◆ Class **twitter** feed
 - ▶ <http://twitter.com/SportsTechAtCMU> -- please make sure to follow asap
 - ▶ Will announce guest speakers, tours, demo days
 - ▶ We already have a few industries/individuals following us
 - This is good publicity for the course, for CMU, and most of all, for YOU!
- ◆ Class **YouTube channel** (look for “SportsTechAtCMU”)
 - ▶ Final-demo video clips will be posted there
 - ▶ Any cool behind-the-scenes video (like the class touring a sports facility)
- ◆ Class **facebook group** (search for “Sports Technology at Carnegie Mellon”)
 - ▶ Join the group – we will advertise this page to industries

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Policies on Collaboration

✓ **What is okay**

- ▶ Collaboration is encouraged/needed for projects within your team
 - Intended to teach you team spirit and the benefits of team work
 - Projects/demos/reports should be substantially the result of your team's efforts
- ▶ Sharing your findings on the mailing list, especially over something tricky
 - Postings from other students can be useful in getting over a tricky lab issue
 - Answering your fellow-students' questions, if you know the answer
 - As an instructor, I actually notice/appreciate individuals who help others



✗ **What is not okay**

- ▶ Using/borrowing code snippets (modified or otherwise) from other teams
 - ▶ Letting someone in your team carry the lion's share of the load in the project
 - We will find you out during demos – in fact, demo questions will target your individual contributions to pinpoint your share of the “load” and your team's originality
 - ▶ Cheating in the design reviews that you are supposed to complete individually
- ◆ **CMU Policy on Cheating and Plagiarism** lists examples of what constitutes cheating <http://www.cmu.edu/policies/documents/Cheating.html>

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Some General Guidelines

- ◆ I expect you to
 - ▶ Attend classes – take this seriously!
 - ▶ Learn how to use hardware/software and try things out for yourself
 - ▶ Know how to find and use technical documentation
 - I will provide some of the more obvious starting points for searches
 - ▶ Do the required reading related to the lectures
 - ▶ Give a polished presentation in class
 - ▶ Show up for every meeting that your team has with me or the TAs
 - ▶ Manage your time and stay on top of the milestones
 - In general, there will be one project milestone every 2 weeks; so, stay on track!
- ◆ Learning material in this course requires participation
 - ▶ This is not a sit-back-and-listen kind of course
 - ▶ Questions are welcome and appreciated
 - ▶ If you see something that is a problem, you need to tell us right away
 - Project issues, hardware issues, lab issues, classroom issues,

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Grading Criteria

- ◆ Breakdown of grading
 - ▶ Mid-semester demo & presentation, 30% of grade [Team]
 - ▶ Final demo & presentation, 30% of grade [Team]
 - ▶ Individual performance in a class presentation, 15% of grade [Individual]
 - ▶ Online documentation & manual, 10% of grade [Team]
 - ▶ Class participation, 10% of grade [Individual]
 - ▶ Peer review from team members, 5% of grade [Individual]
- ◆ Grading Scale
 - ▶ 90% - 100% A
 - ▶ 80% - 89% B
 - ▶ 70% - 79% C
 - ▶ 60% - 69% D
 - ▶ 0 - 59% R

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Details of Grading Milestones



- ◆ Mid-semester demo & presentation – 30% of grade
 - ▶ Outline will be clearly provided to all teams
 - ▶ We will build up to this through two prior 5-minute talks
- ◆ Final demo & presentation – 30% of grade
 - ▶ Outline will be clearly provided to all teams
 - ▶ We will build up to this through three prior 5-minute talks
- ◆ Individual performance in a class presentation – 15% of grade
 - ▶ You will make a solo presentation on a sports-technology topic
 - ▶ Every team member owns a chunk of the team's mid-term and final presentations
- ◆ Online documentation & manual – 10% of grade
 - ▶ Outline will be clearly provided to all teams
 - ▶ Incrementally built up through the phases of the project
- ◆ Class participation & design reviews – 10% of grade
 - ▶ Individual response to others' email questions, finding & posting useful resources, sharing tricky debugging tips, providing material for improving course – 5%
- ◆ Peer review from team members – 5% of grade

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What Will You Learn?

- ◆ *Engineering skills*
 - ▶ Meeting constraints -- cost, performance, dependability, security, timing
- ◆ *Practical systems skills*
 - ▶ Sub-system integration, debugging, quality assurance
- ◆ *Analytical skills*
 - ▶ Data analysis, system modeling, empirical methods
- ◆ *Inter-disciplinary skills*
 - ▶ Combination of signal processing, wireless communications, computer hardware, computer software, distributed systems, computer architecture
- ◆ *Team skills*
 - ▶ How to cooperate to achieve your goals
- ◆ *Technical communication skills*
 - ▶ Speaking, writing, data presentation
- ◆ Hopefully, a lot more about *sports technologies* than you knew coming in!

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Significant Design Project

- ◆ This course will help you to gain these skills through a project
- ◆ Project is necessarily open-ended
- ◆ What kind of project?
 - ▶ Sizable: Significant undertaking that involves a design concept and takes it all the way through to a “solution”
 - ▶ Practical: Attempts a “solution” of value or utility
 - Think of a sports technology on the market in 2-5 years’ time
 - **Don’t build something that you won’t envision being used!**
- ◆ Keep in mind other factors/constraints that influence sports technologies
 - ▶ Cost – to the facilities, to the team, to the broadcasters
 - ▶ Feasibility – it has to “fit” within the nature of the game, it can’t disrupt the way the game is played, it has to improve **something**

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Project Ideas

- ◆ I will present some ideas (from different industries) in the next lecture
 - ▶ You can feel free to pick up some of these “sponsored” projects
 - You might need to sign an IP waiver for CMU to own the IP (industry usually has some agreement with CMU, in return for providing the idea and funding for it)
- ◆ You are welcome (no, scratch that – *encouraged*) to come up with ideas!
- ◆ Showcase the unique aspects of sports
 - ▶ Understanding of the physics of sports, nature of a specific sports, constraints on players/coaches/broadcasters, rules of the game itself
 - ▶ Viewing, coaching, training, scouting, rehab, broadcasting – all these count!
- ◆ Figure out your target audience
 - ▶ Coach, player, broadcast network, sports facility, trainer, sports doctor
 - If you can interview your target audience, go for it!
 - ▶ Otherwise, gather “evidence” (blogs, news articles, anecdotes) to convince me that you are addressing a real problem
 - ▶ Don’t make up a toy problem that won’t result in a real sports technology
- ◆ Fair game to involve mobile, embedded, video, etc.

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Phases of the Project

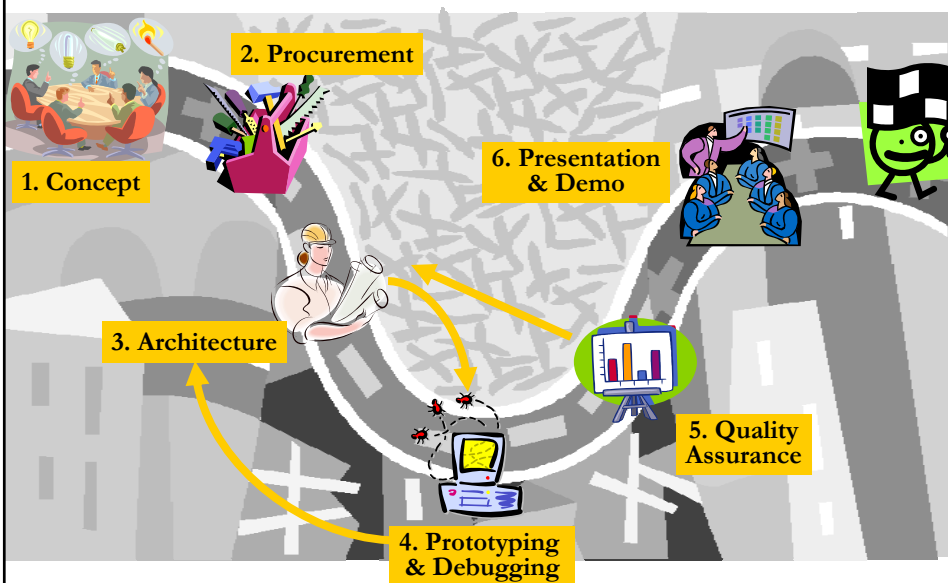
- ◆ Emphasis on good (but lightweight) process and high quality design
- ◆ Several project phases to spread out work and reduce risk

- ◆ Major checkpoints as a part of the project – deliverables for the course
 - ▶ Mid-semester and final presentations
 - ▶ Mid-semester and final demos of “solution”
 - ▶ Online documentation of working “solution”
 - ▶ Poster and demo session with industrial visitors

- ◆ Minor checkpoints – check-off items for your project’s design reviews
 - ▶ Team formation and concept articulation
 - ▶ Project proposal and requirements
 - ▶ Design and architecture
 - ▶ Test plan and experimental validation
 - ▶ Data analysis and evaluation

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Project Roadmap



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Both Ends of the Bargain



Your end of the bargain for the project

- ◆ You show up to class – no kidding, no excuses
- ◆ You get to propose the project that you want to build
- ◆ You get to decide what kind of hardware you want
 - ▶ Of course, you then get to live with the consequences!
 - ▶ You do the debugging of the hardware – TAs will help where they can
- ◆ You provide project status updates in class every two weeks
- ◆ You meet the milestones for the project
- ◆ You do an interim mid-semester demo and a final end-semester demo

My end of the bargain for the project

- ◆ I will provide the hardware that you want to use for your project
 - ▶ And if we don't have the hardware you need, I will supply the funds to acquire it (within reasonable limits) [Porsche-drivers need not apply]
- ◆ I will provide the starting points for the lectures you need to create/present
- ◆ I will ensure that you stay on track with the various phases of the project
- ◆ I will meet with you in person once every 3-4 weeks
- ◆ I will help to locate resources if you need more assistance

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Team Work

- ◆ Project will be done in a team of **four** students
- ◆ As a team member, you are expected to contribute *fairly* to your team's project, from concept to prototype
 - ▶ Design, implementation and evaluation phases
 - ▶ Accomplishment of major & minor milestones
 - ▶ Drafting and giving team presentations
 - ▶ Preparing and giving your team's presentation
 - ▶ Attend design review meetings (CIC 2202)
 - ▶ Participate in design review meetings
 - ▶ Participate in demo sessions
 - ▶ Day-to-day management of the project

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Engineering Aspects of Projects to Consider

- ◆ Timing and performance issues
- ◆ Mobility and motion-sensitivity
- ◆ Geographical distance between components
- ◆ Location-awareness
- ◆ Physical dimensions (portability)
- ◆ Memory footprint (how much memory you need)
- ◆ Energy (or battery power) issues
- ◆ Distribution/networking of components
- ◆ Display for the user
- ◆ Speed of operation (influenced by processor speed)
- ◆ Theoretical and algorithmic aspects
 - ▶ Signal processing, feedback control, localization, encryption
- ◆ I will look for all of these aspects when evaluating your project proposal

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Your Immediate Deliverables

1. **5pm, Friday, 28 Aug 2009**: Email me your list of team members
 2. **5pm, Saturday, 29 Aug 2009**: Email me your project idea(s) to look over before you meet with me
 3. **2-5pm, Monday, 31 Aug 2009**: Meet with me for 15 mins as a team
 - ▶ Sign up for a 15-min time-slot to meet with me -- first-come, first-served
 - ▶ *Entire team must attend every scheduled meeting with me*
- ◆ **Agenda for meeting with me**
 - ▶ Look over your project ideas and novelty of project
 - ▶ Discuss components required
 - Protocols, hardware, software, number of parts, budget, technical support
 - ▶ Discuss risks and risk-mitigation strategies
 - I usually like to see a Plan A, a Plan B and also a Plan C
 - ▶ Please bring any written material (e.g., diagrams) that facilitates our discussion

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Deliverables

- ◆ Deliverable #1: Team list
 - ▶ Four people per team
 - ▶ Name of each person and email address

- ◆ Deliverable #2: List of project concepts you've brainstormed
 - ▶ Each project concept should cover the following (in your email to me)
 - ▶ Sport: Which sport?
 - ▶ Target audience: Whom does it impact? (coach, player, broadcast, etc.)
 - ▶ Impact: Why should anyone care? Why is it game-changing (literally)? What evidence (news articles, press) do you have that you're solving a problem that will have impact if you solve it?
 - ▶ Competition: What comes closest to this out there? (send me links)
 - ▶ Parts: What do you need to realize this concept? (hardware, software, etc.)
 - ▶ Proof-of-concept: How will you show this working on the final demo day?

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Project Proposal [to be presented by you on 2nd Sept 2009]

- ◆ We will go through the “official” format for a project proposal in the next lecture

- ◆ Think of a **field-demo** scenario that you will be able to show me
 - ▶ If you wanted to showcase your sports technology, what would you put into a five-minute video clip to pitch your product to a sports team or broadcast network?
- ◆ Even better if you can think of a “Before” and “After” scenario
 - ▶ How do people do things without your product now?
 - ▶ How will the sports industry change after your product hits the street?
- ◆ Important to have done a **competitive analysis**
 - ▶ What's out there that competes with your proposed product?
 - ▶ Why is your product any better or different?
 - Perhaps an issue of quality: Faster, cheaper, more reliable, more accurate
 - Perhaps an issue of features: “We can do X while others cannot”
- ◆ **Success criteria**
 - ▶ How will you (and I) know that you're done?
 - ▶ Qualitative – “We will demonstrate feature X in our product”
 - ▶ Quantitative – “We will demonstrate that we can do X in y seconds for z users”

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Project Proposal – II

- ◆ Equipment needed
 - ▶ Hardware
 - ▶ Software
 - ▶ Budget

- ◆ Procurement issues
 - ▶ Can you get hold of the components?
 - ▶ Will they work? Do they have a history of being used? Resources for support?

- ◆ Every team will need to sign a form for the loan of hardware equipment needed/used in the project
 - ▶ All team members will need to be present to sign this form at the time that you “check out” the hardware
 - ▶ All team members will need to sign this form when you return the hardware
 - ▶ All the hardware must be returned before your final grade is assigned for the course

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Team Project Websites

- ◆ All of your milestones should be submitted by uploading the specific deliverable to your project website by the stipulated deadline
 - ▶ I will use the information on this site for grading purposes
 - ▶ Once teams form, we will get these ready and send out information soon

- ◆ We will provide a template for project website
 - ▶ Feel free to embellish and be creative – this template is just a starting point containing items that I would like to see on your project website
 - ▶ We will walk through this in the lecture next week – no rush as yet

- ◆ Please keep your team’s website up to date with
 - ▶ Design, architecture and test documents
 - ▶ Working versions of code
 - ▶ Presentations made in class

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Let the Insanity Begin!

➔ Milestone 1 – August 28th

- ▶ Form a team of 4 and send me an email with your team list
- ▶ Start brainstorming project ideas with your team
- ▶ Follow the class twitter, become a member of the Facebook group

◆ Milestone 2 – August 29th, 5pm

- ▶ Send me multiple project concepts by email
- ▶ Sign for a 15 minute time-slot for a meeting on August 31st
 - On my Andrew/Oracle calendar – first-come, first-served

◆ Milestone 3 – August 31st, 2-5pm

- ▶ Design review with me to discuss/finalize concepts, get some initial feedback in person

◆ Milestone 4 – September 2nd

- ▶ Present your project proposal in class for 5 minutes (per team)
 - Your sports technology concept, why it matters, why it will revolutionize the industry
 - The kind of hardware/software/platforms you need
 - Competitive analysis to convince all of us that this will make a difference

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What You Should Be Doing Now

◆ Brainstorm project ideas with your team members

- ▶ *You will need to convince me that the sports industry will actually care about your team's concept and that nobody else is doing something similar!*
- ▶ Bring multiple ideas just in case we nix some of them

◆ Think about the procurement of parts for each of your project ideas

- ▶ Don't wait to run your ideas past me to start thinking about the parts you need, how long it will take to order them, and your budget
- ▶ Do not forget all the cautionary advice on choosing unsupported hardware

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Outcomes of First Meeting (on Aug 31)

- ◆ Together, we will
 - ▶ Finalize your project concept – you now have the go-ahead to find the parts and to build what you need to
 - ▶ Determine your end users and whether we can get access to them
- ◆ I will
 - ▶ Assign a dedicated TA to work with your team (and a backup TA, in case the first TA is traveling or not available)
 - Your TA will meet with you every week and then give me a report on how your team is doing
- ◆ You will
 - ▶ Update your website with the finalized project concept so that we can advertise the teams/concepts to all the industries involved
 - ▶ Start thinking through the architecture and specs of your project
 - ▶ Start working with your TA to order parts

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Review of Lecture

- ◆ This lecture
 - ▶ Logistics, grading criteria, policies
 - ▶ Introduction to the course
 - ▶ Schedule of lectures and milestones
 - ▶ Expectations on both sides
 - ▶ Some project ideas
- ◆ Next lecture
 - ▶ Project proposal overview
 - ▶ Project expectations
- ◆ Project status
 - ▶ What's done
 - Pretty much nothing at this point, except deciding on your team members and brainstorming project ideas
 - ▶ What's next
 - In-person design review with me on Monday, 8/31 in my office (CIC 2202)

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