AN INTRODUCTION TO
INTELLIGENT TRANSPORTATION SYSTEMS

1.212
SPRING 2005

Professor Joseph M. Sussman

Mon/Wed 2:30-4

BLOCK 1
(Lectures 1, 2)

INTRODUCTION TO ITS
Basic Concepts

SPEAKER: Joseph M. Sussman
MIT

February 2, 2005
DEFINITION OF ITS

- Intelligent Transportation Systems (ITS) apply well-established technologies of communications, control, electronics and computer hardware and software to the surface transportation system.
WHAT 1.212 IS ABOUT

◆ It’s a transportation class, with all that implies
◆ It’s a policy class -- how transportation relates to major societal goals
◆ It’s a technology development and deployment class
◆ It’s a complex system (CLIOS) class
◆ It’s a “Regions” class
  ◆ Planning
  ◆ Architecture
◆ It’s an organizations/institutions class
◆ It’s an advanced research ideas class
# 1.212 CLASS SYLLABUS

## Spring 2005

<table>
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<tr>
<th>Block</th>
<th>Topic</th>
<th>Lectures</th>
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<tr>
<td>1</td>
<td>Introduction to ITS, including where ITS fits; roles and responsibilities</td>
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<td>2</td>
<td>Advanced Traveler Information Systems (ATIS), including functionality; business models; field trip to SmartRoute Systems</td>
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<tr>
<td>3</td>
<td>Advanced Transportation Management Systems (ATMS), including network operations; incident detection; congestion pricing, tolling, HOT lanes, example deployments</td>
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<td>4</td>
<td>Fleet-oriented ITS services, including Advanced Public Transportation Systems (APTS); BRT; Commercial Vehicle Operations (CVO); Intermodal Freight, including International Operations and Supply Chains</td>
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<td>5</td>
<td>ITS and Technology, including automated highway systems (AHS); sensors, electronic toll collection (ETC); dedicated short range communication; standards</td>
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<td>6</td>
<td>Regionally-scaled ITS deployment, including regional architecture; organizational and institutional issues; standards; developed vs. developing countries; ITS and strategic regional transportation planning; Integrating infrastructure and operations planning</td>
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<td>7</td>
<td>Critical ITS Issues, including (as time permits) ITS and security; safety; human factors; privacy; sustainability; funding (as contrasted with conventional infrastructure); technology deployment/R &amp;D/policy; other institutional issues</td>
<td>4</td>
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<td>8</td>
<td>Conclusion, including regional ITS planning and architecture presentation; the future of ITS</td>
<td>3</td>
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STUDENT REQUIREMENTS

1. One short (7 pages) assignment.
2. “Mini” Term Paper (about 10 pages -- topic to be “negotiated” with Professor Sussman); submitted right after Spring Break.
   A. Critical review of selected ITS literature
   B. A paper or analysis on some topic of interest to you.
3. Readings
4. Group Regional ITS Planning and Architecture Project (second half of semester)
5. Discussion Articles -- We will distribute several articles that will be discussed (interactively) at the next lecture. We will ask you to write a brief summary of the article to be submitted before the discussion.
6. Class Participation
BIG ITS IDEAS

◆ The ITS-4 Technologies
◆ The ITS Insight: Linkage of Vehicle and Infrastructure
◆ Regionalism
◆ Intermodalism
◆ Information
◆ Mobility
◆ The Potential of Pricing
◆ Institution Building
◆ Institutional Change
◆ Nationally-Consistent System
◆ Internationally-Consistent System
THE FUNDAMENTAL ITS INSIGHT

- Linkage of vehicle and transportation infrastructure through ITS infrastructure.

Diagram:

- VEHICLE
  - ITS INFRASTRUCTURE
    - SENSORS
    - COMMUNICATIONS
    - IT
    - ALGORITHMS
  - TRANSPORTATION INFRASTRUCTURE (BROADLY DEFINED)
THE ITS-4 TECHNOLOGIES

◆ Sensing
◆ Communications
◆ Computing
◆ Algorithms
SOME VEHICLE FEATURES

Telematics: In-vehicle equipment

- Transponder
- Cell Phone, PDA
- Lap Top
- Sensors (e.g., for intelligent cruise control)
TRANSPORTATION SYSTEM DIMENSIONS

GEOGRAPHIC SCALE
- Urban
- Regional
- National
- Global

ORGANIZATIONAL SCALE
- Integrated Supply Chain
- Intermodal
- Modal

TIME SCALE
- Real-Time
- Tactical Planning
- Strategic Planning

APPROACHES
- Quantitative Models (OR, Simulation, …)
- Qualitative Frameworks for Analysis
- Transportation Domain Knowledge
DRIVING FACTORS IN TRANSPORTATION

- Economic Development
- Quality of Life
- Social Equity
- Sustainability
- Environmental Issues

TECHNOLOGIES

RESOURCES / EXTERNALITIES

ISSUES

INSTITUTIONAL AND ORGANIZATIONAL REALITIES
ITS at the Nexus of Major Issues

- Congestion and the environment on the public agenda
- Financing of transportation infrastructure, with gas tax revenues under pressure
- Focus on operations in many fields including transportation
- The *region* as the unit of economic competition and environmental management - the concept of Regional Strategic Transportation Planning (RSTP)
- Architecture as a key idea in many kinds of large scale engineering systems
BIG, WORLD-WIDE CHANGES
Mid-1980s to the Present --

WHERE DOES ITS (AND, MORE BROADLY, TRANSPORTATION) FIT?
CONTEXT
(at the time of the 1991/2 strategic plan)

◆ Transportation at a “Crossroads” (Congestion, Safety, Environment, Energy and Productivity)
  Can’t build our way out of it
◆ ITS Addresses All These Key Issues
◆ Technology -- No Breakthrough Needed
◆ Institutions -- Partnerships
◆ Transportation -- Information Infrastructure
◆ Broad-based Set of Benefits
GOALS FOR ITS IN THE U.S.
(at the time of the 1991/2 strategic plan)

- Improved Safety
- Reduced Congestion
- Increased and Higher Quality Mobility
- Reduced Environmental Impact
- Improved Energy Efficiency
- Improved Economic Productivity
- A Viable U.S.ITS Industry
VISION
(at the time of the 1991/2 strategic plan)

◆ A national system that operates consistently and efficiently across the U.S. to promote the safe, orderly and expeditious movement of people and goods.

◆ An efficient public system that interacts smoothly with improved highway operations.

◆ A vigorous U.S. ITS industry supplying both domestic and international needs.
## ITS “RECENT” U.S. HISTORY

<table>
<thead>
<tr>
<th>Year</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>Early 1970s</td>
<td>Electronic Route Guidance (ERGS)</td>
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<tr>
<td>1986</td>
<td>California (CALTRANS)</td>
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<tr>
<td>1987</td>
<td>Federal government (FHWA)</td>
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<tr>
<td>1990</td>
<td>Mobility 2000</td>
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<td>1991</td>
<td>Formation of ITS America</td>
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<td>1991-2</td>
<td>Strategic Plan Development</td>
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<td>1991</td>
<td>ISTEA (Intermodal Surface Transportation Efficiency Act)</td>
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<td>1994</td>
<td>ITS Architecture Contracts</td>
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<td>1996</td>
<td>Major Regional Initiatives</td>
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<td>1997</td>
<td>Automated Highway Demonstration in San Diego</td>
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<td>1998</td>
<td>TEA-21</td>
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<tr>
<td>2002/3</td>
<td>Ten-Year ITS Plan</td>
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<td>2003/4</td>
<td>TEA-21 Reauthorization</td>
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FUNDAMENTAL ATMS/ATIS SYSTEMS

ATMS - Advanced Transportation Management System (Operator)
ATIS - Advanced Traveler Information System (Customer)
SOME FUNCTIONS

◆ Manage and monitor the network traffic flows
◆ Provide information on the state of the network
◆ Fleet management (vehicle location)
  ◆ Trucks
  ◆ Buses
◆ Monitoring vehicle condition and status
  ◆ Trucks
  ◆ Buses
◆ Autonomous systems
  ◆ Vehicle status
  ◆ Intelligent cruise control
  ◆ Obstacle detection
SOME KEY ITS CONCEPTS (I)

- The Need for Organization Innovation
  - Public/Private Partnership
  - All Levels of Government
  - Changes in the Definition of a “Transportation Professional”
  - Academic/Research Role
- Building a U.S. ITS Industry/Test of the Marketplace
  - International Competition for the ITS Market
  - The Role of the Auto Manufacturer
  - The Role of the Information Service Providers
  - The Size of the Public and Private Markets
  - ITS as a National System
  - Standards and Protocols
SOME KEY ITS CONCEPTS (II)

◆ Productivity and International Competitiveness
  ◆ Congestion
  ◆ Safety
  ◆ Sustainability
    ◆ Environment
    ◆ Energy
  ◆ Mobility
◆ Limits on “Build More Highways” Option
◆ ITS as an Enabling Technology --
  ◆ The TRANSPORTATION/ INFORMATION INFRASTRUCTURE
  ◆ An Extended Definition of Infrastructure
  ◆ Integration of IT, Communications, Sensors
◆ Spending on Infrastructure Works
  ◆ Productivity Improvements
  ◆ Examples:
    ◆ Interstate System
    ◆ Air System
◆ ITS and the Regional Scale