

### GIS Applications



Vehicle Navigation and Transportation



### Using GIS to Navigate

- Going from point A to point B
- Avoiding congestion
- Optimizing routes
- Minimizing costs



### Commercial and Industrial Uses

- Fleet tracking
- Route planning
- Schedule management
- Delivery optimization





COMPLETION AND OPENING OF THE S. S. RAIL ROAD. BROOKLYN TO GREENPORT BY RAIL.

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### Vehicle Navigation Requirements



- Current position
- Radio location
  - Dead reckoning
  - Proximity beacon
- Destination
- Directions
- verbal
  - visual

## Model Components

- Network model (roads)
- Digital maps
- Terrain model (elevation)

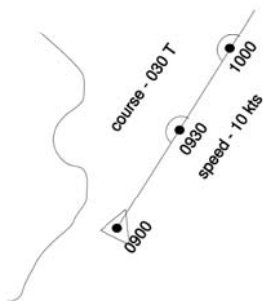
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## Vehicle Navigation

- Global Positioning System
  - Microwave transmissions from satellites
- Dead reckoning
  - Wheel sensors
  - Compass
  - Odometer/Speedometer coupling

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## Dead Reckoning



- Initial position
- Heading
- Distance (Speed\*Time)

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## Subsurface Vessels



- SSBNs or "boomers"
- SSNs or "fast attack"
- UUVs

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## Marine Precision Navigation System

- GPS constitutes a security risk
  - Signals can be jammed or spoofed
  - Submarines must surface to detect
- Maintain accuracy without relying on GPS
  - Reduce errors in inertial systems
  - Exploit subsurface terrain matching

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## Inertial Navigation Systems (INS)

- Accelerometers (gyros)
- Universal Gravity Module
- Velocity sonar

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## Gyroscopes



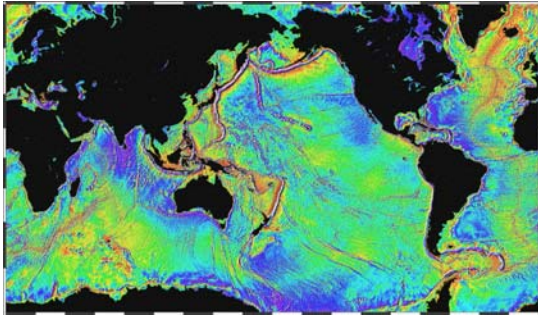
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## Universal Gravity Module

- Gravity Passive Navigation
- Terrain Estimation and Map Matching

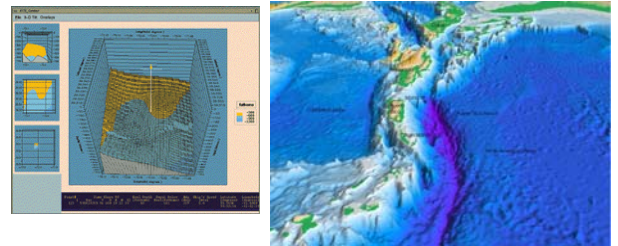
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## Gravity Passive Navigation



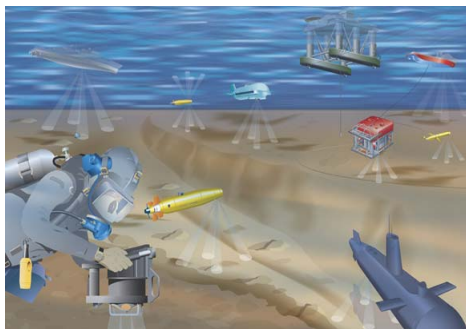
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## Terrain Contour Matching



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## Velocity Sonar Technology



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## In Summary

- Inertial Navigation Systems rely on dead reckoning
  - Relative position information
  - Updated by heading and speed (velocity)
- INS combined with GPS or other absolute positioning yields the best results

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