



MIT International Center for Air Transportation

Grounding of the Panamanian Passenger Ship *Royal Majesty*

Ada Lim

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February 26, 2004

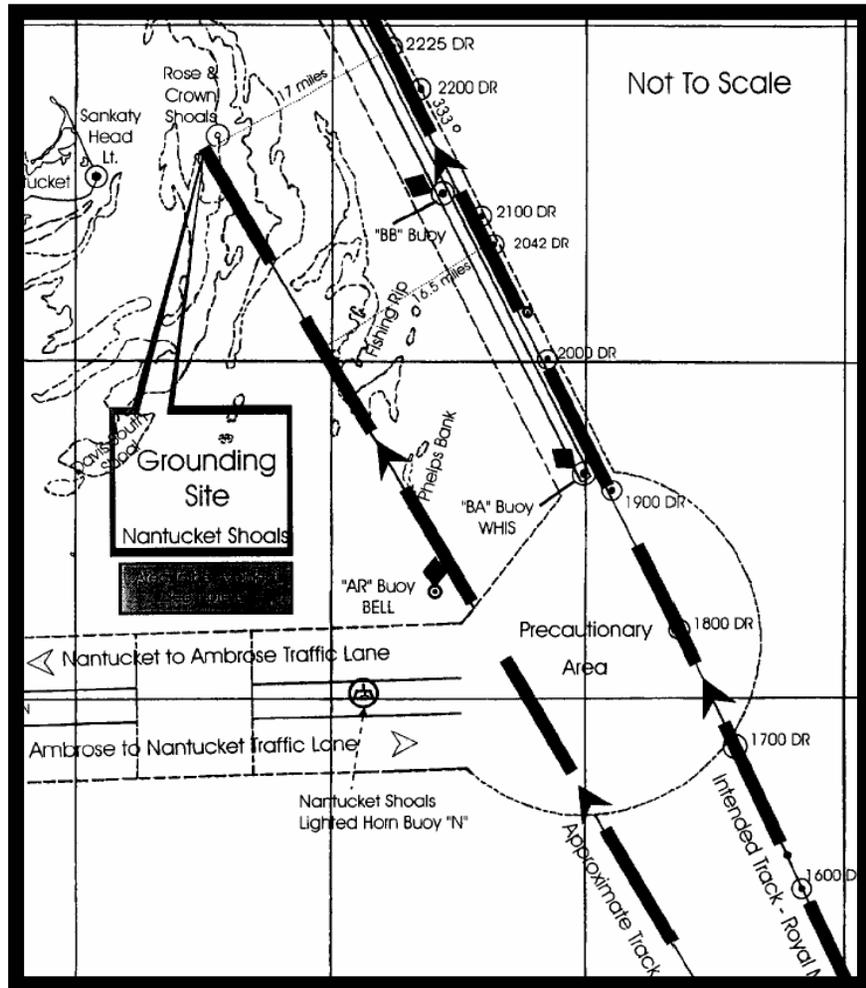
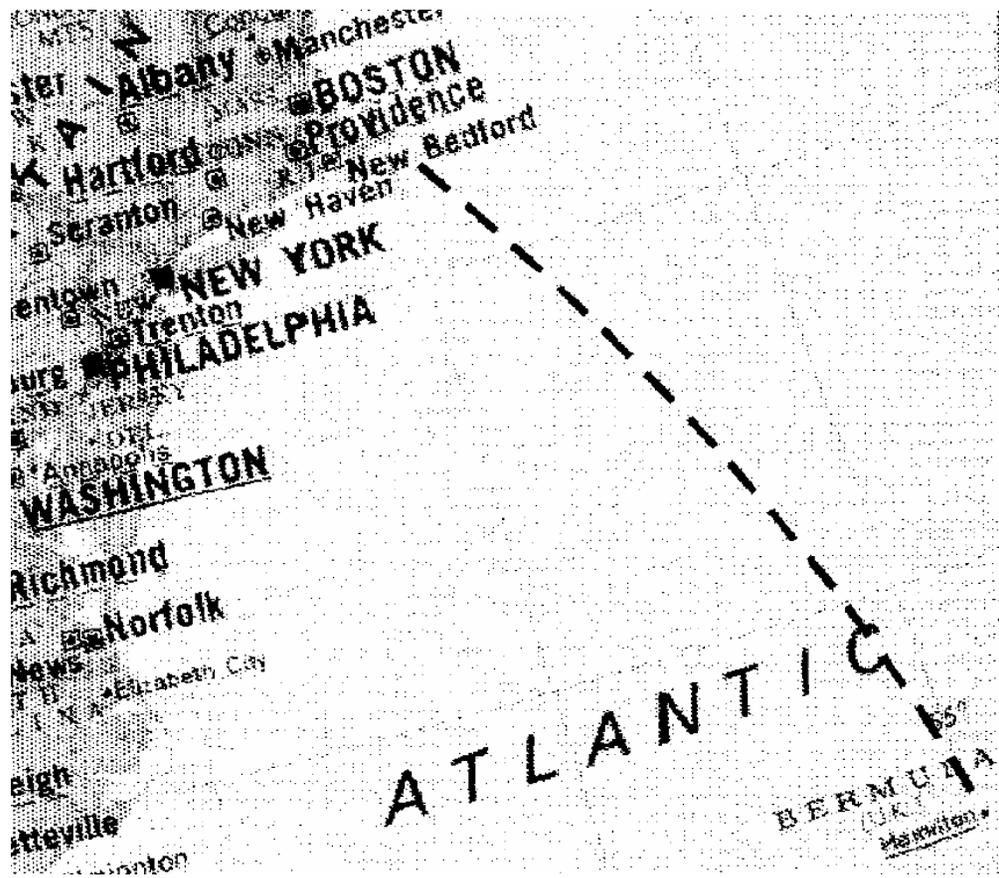
Royal Majesty

- Launched in 1992
- 1509 persons on board
- Panamanian registry
- Integrated Bridge System
- 568 feet long
- ~ 20 feet draft
- ~30,000 ton
- 19 knots





Planned and Actual Route



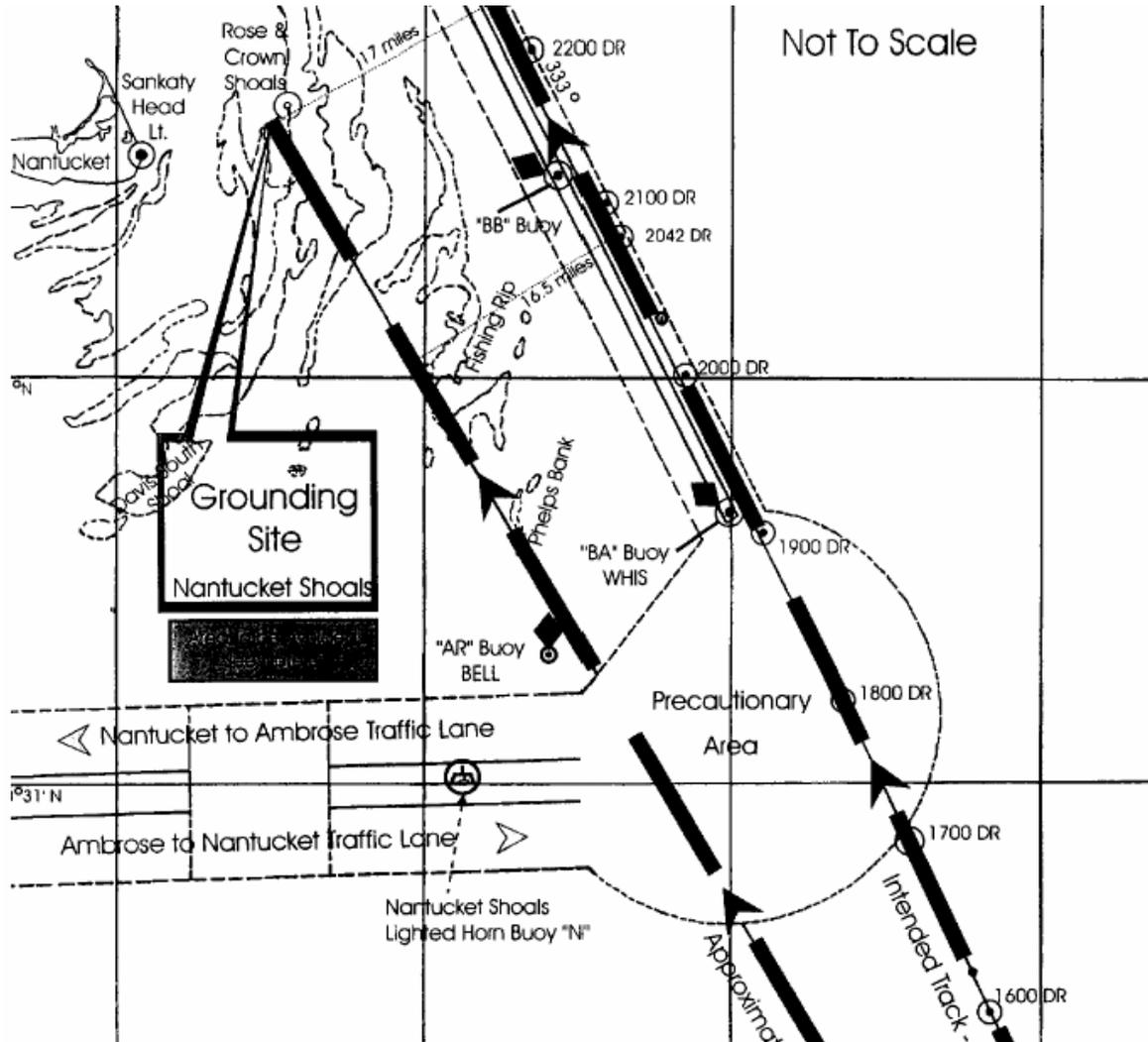
Pictures from NTSB report PB97-916401



Summary of Events

- ***Royal Majesty* left Bermuda at noon, June 9, 1995**
- **~ 1 pm appears that GPS antenna cable became detached from GPS unit**
 - GPS unit reverted to dead-reckoning mode
 - Alarms undetected by human operators
 - Other equipment presumed still operating in GPS mode
- **For remainder of voyage autopilot used position estimates uncorrected for effects of wind, current and sea state**
- ***Royal Majesty* ran aground of Nantucket at 10:25 pm, June 10, 1995**

Final Approach to Nantucket



- Hourly course checking from GPS
- Buoys detected by radar without visual verification
- Yellow and red lights sighted
- Fishing vessels radio in course warning
- Buoy reported as sighted when unseen
- Blue/white water seen
- Runs aground

Picture from NTSB report PB97-916401



NTSB Findings as to Probable Cause

- **Over reliance on automated features of Integrated Bridge System (IBS)**
- **Implications of automation for Bridge Resource Management**
- **Deficiencies in design and implementation of IBS**
- **Deficiencies in procedures for operation of the IBS**
- **2nd Officers failure to take corrective action on detection of anomalies**
- **Inadequacy of international design and training standards for IBS**



Key Supervisory Control Issues

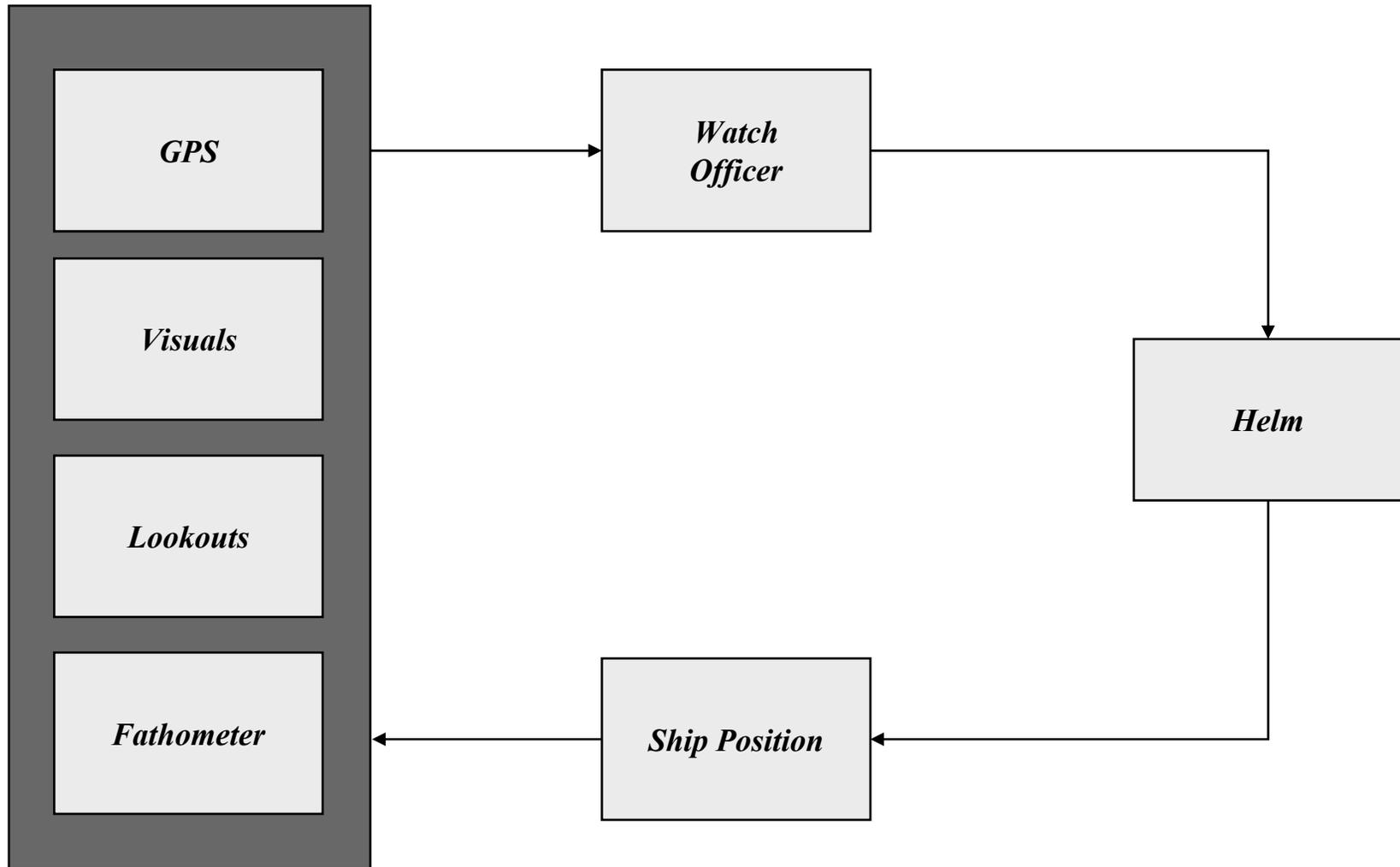
- **Keeping operators “in-the-loop”**
- **Appropriate feedback of sub-system states**
- **Monitoring automation performance and error detection**
- **Confirmation bias**
- **Training**



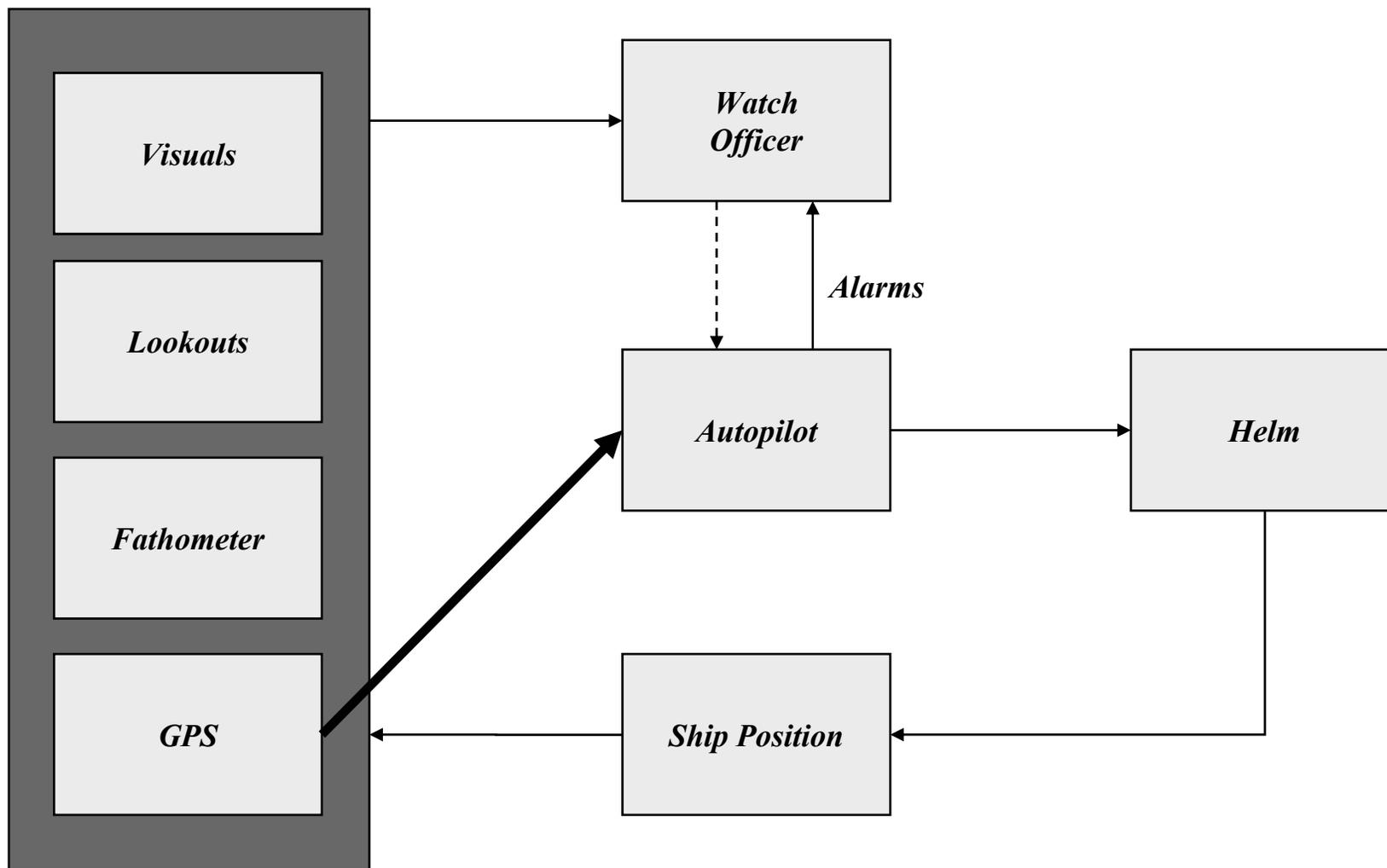
Key Supervisory Control Issues

- **Keeping operators “in-the-loop”**
 - “The watch officer, who previously was active in obtaining information about the environment and used this information for controlling the ship, is now ‘out of the control loop’” (NTSB, 1995)

Traditional Control Loop



Automated Control Loop



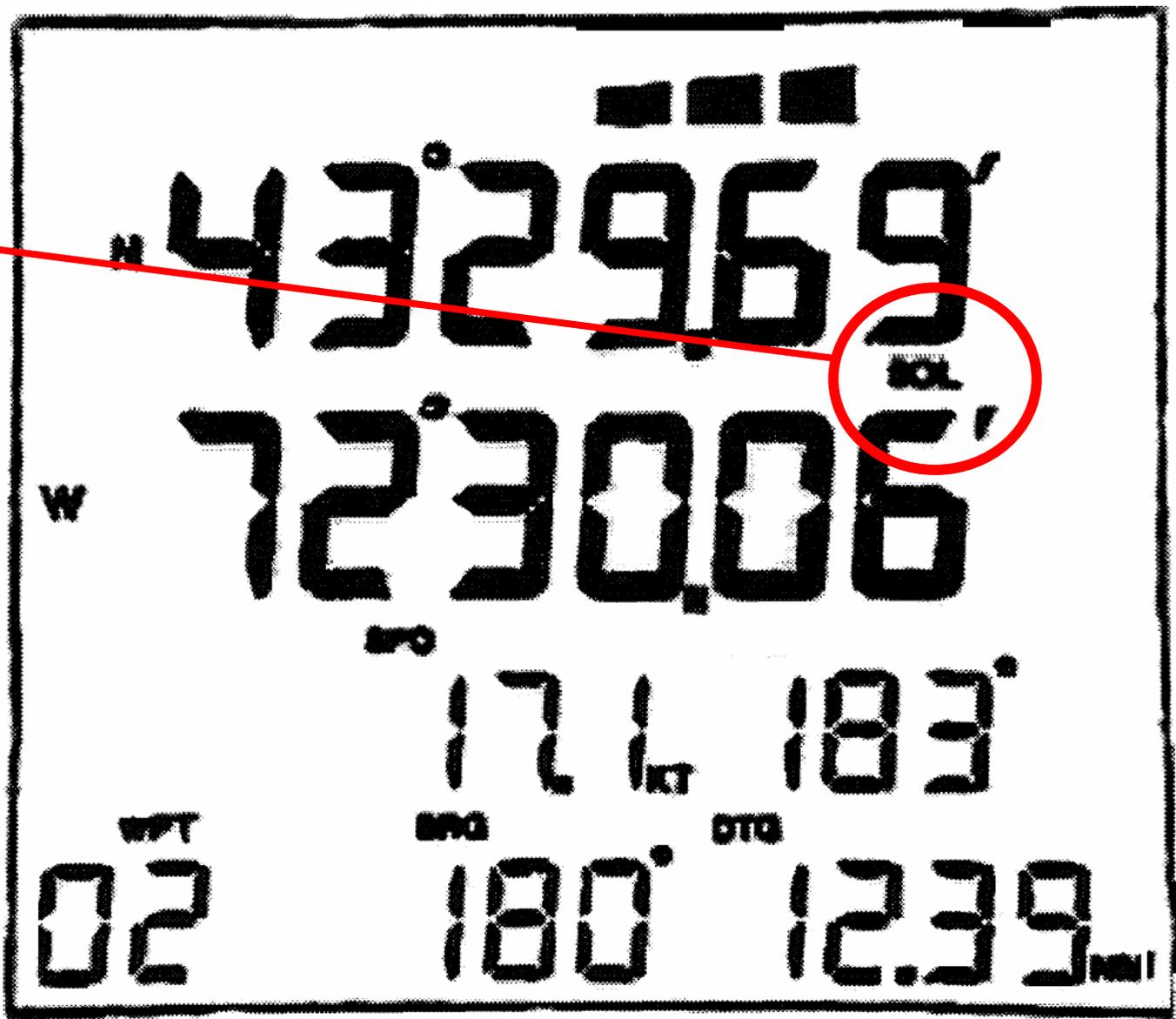


Key Supervisory Control Issues

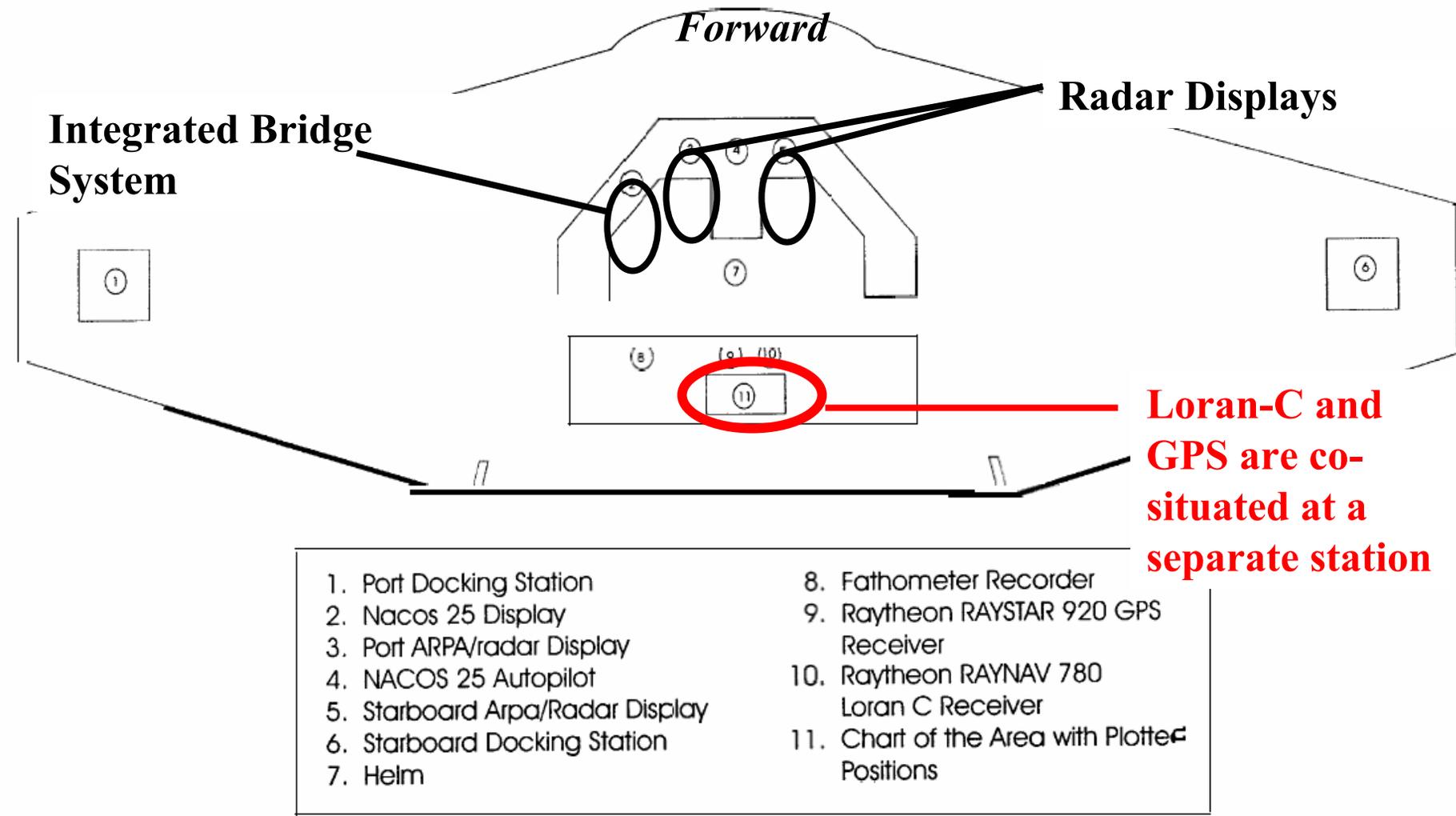
- **Appropriate feedback of sub-system states**
 - Feedback of GPS mode was available, but required movement and attention to small detail

Limited Feedback of GPS Mode:

- 1) “SOL” is displayed
- 2) “DR” is displayed (where?)
- 3) Aural alarms on transition



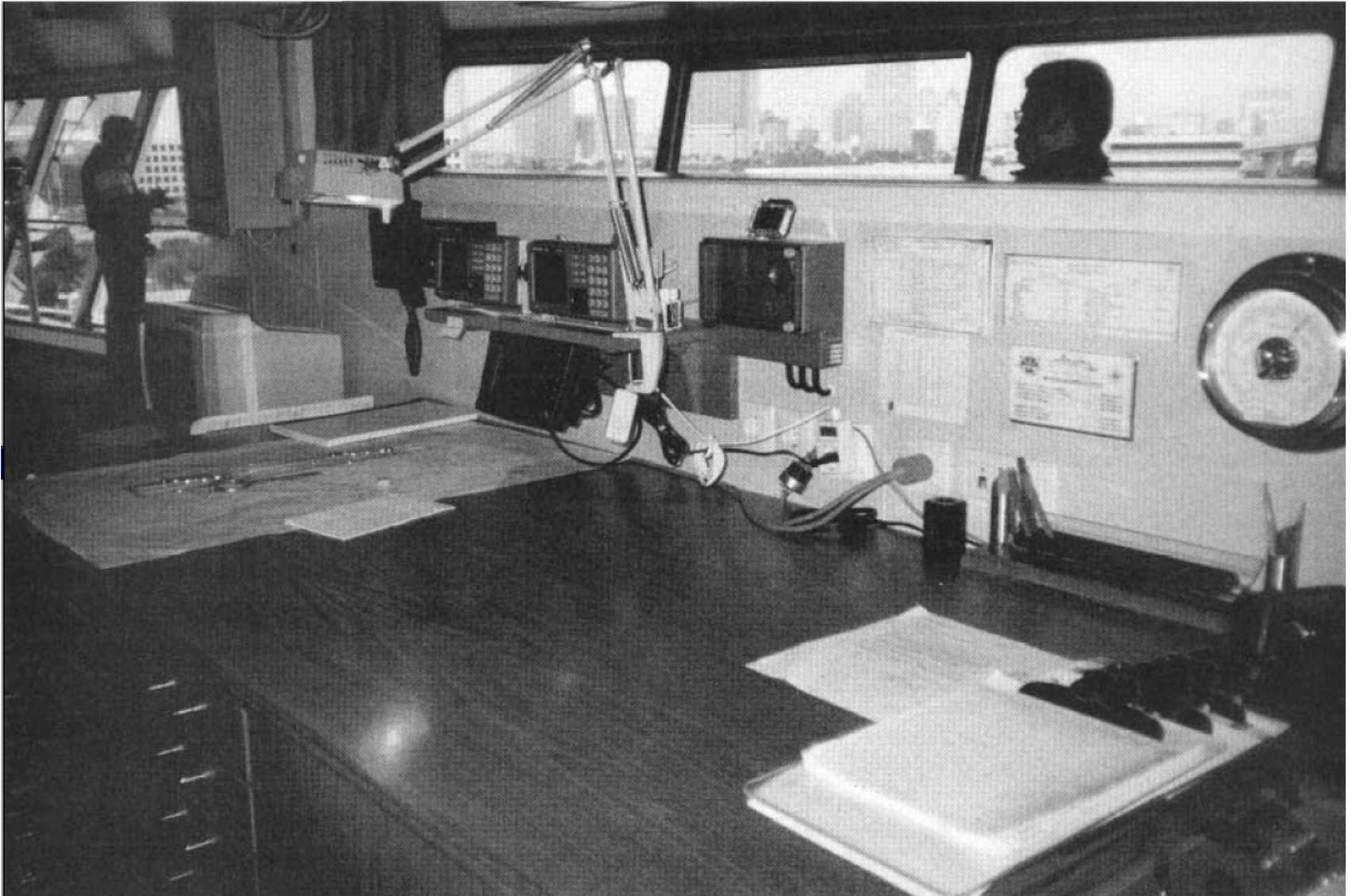
Bridge Layout



Picture from NTSB report PB97-916401

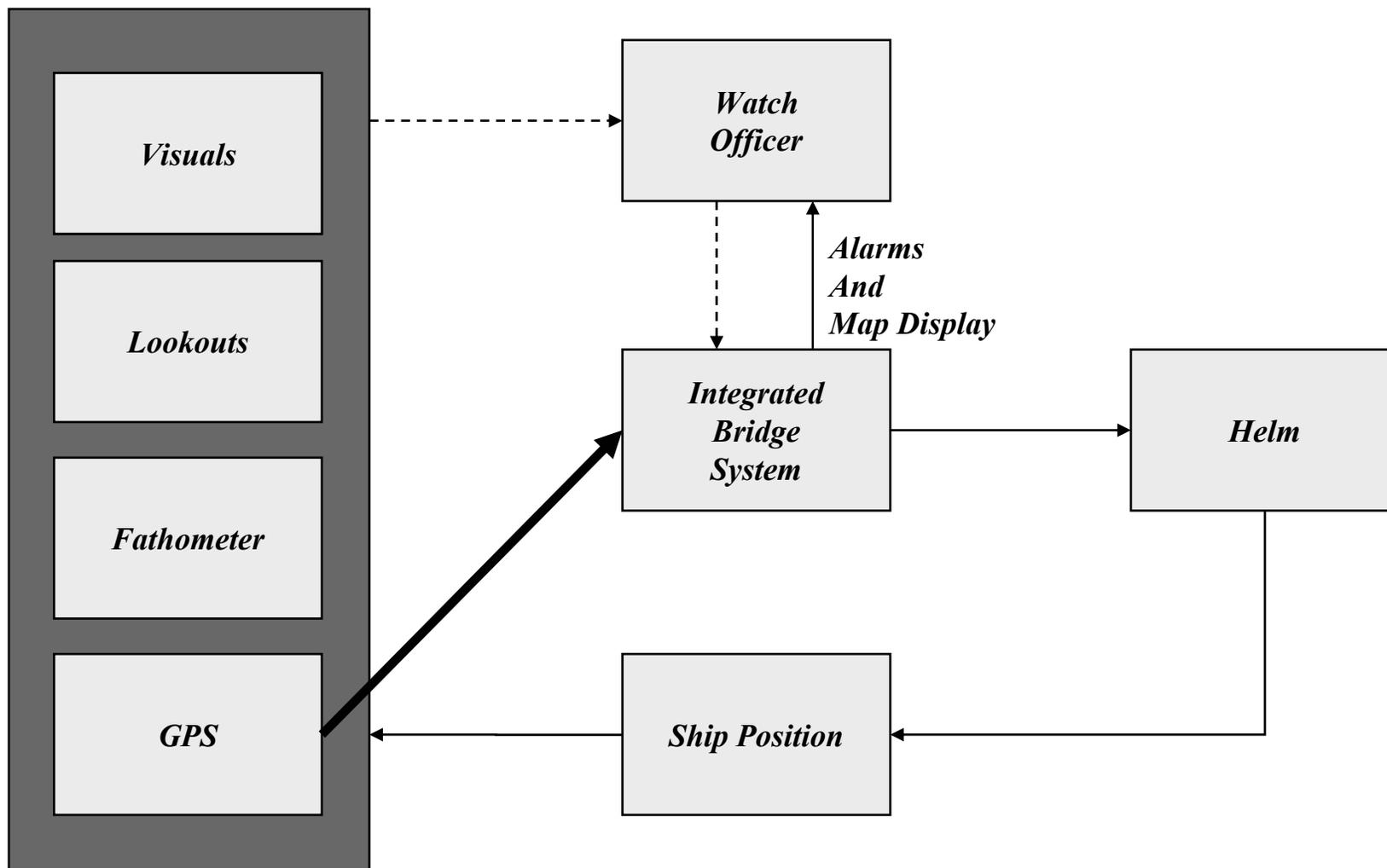
Figure 3—Bridge layout.

Bridge Layout



Picture from NTSB report PB97-916401

Automated Control Loop

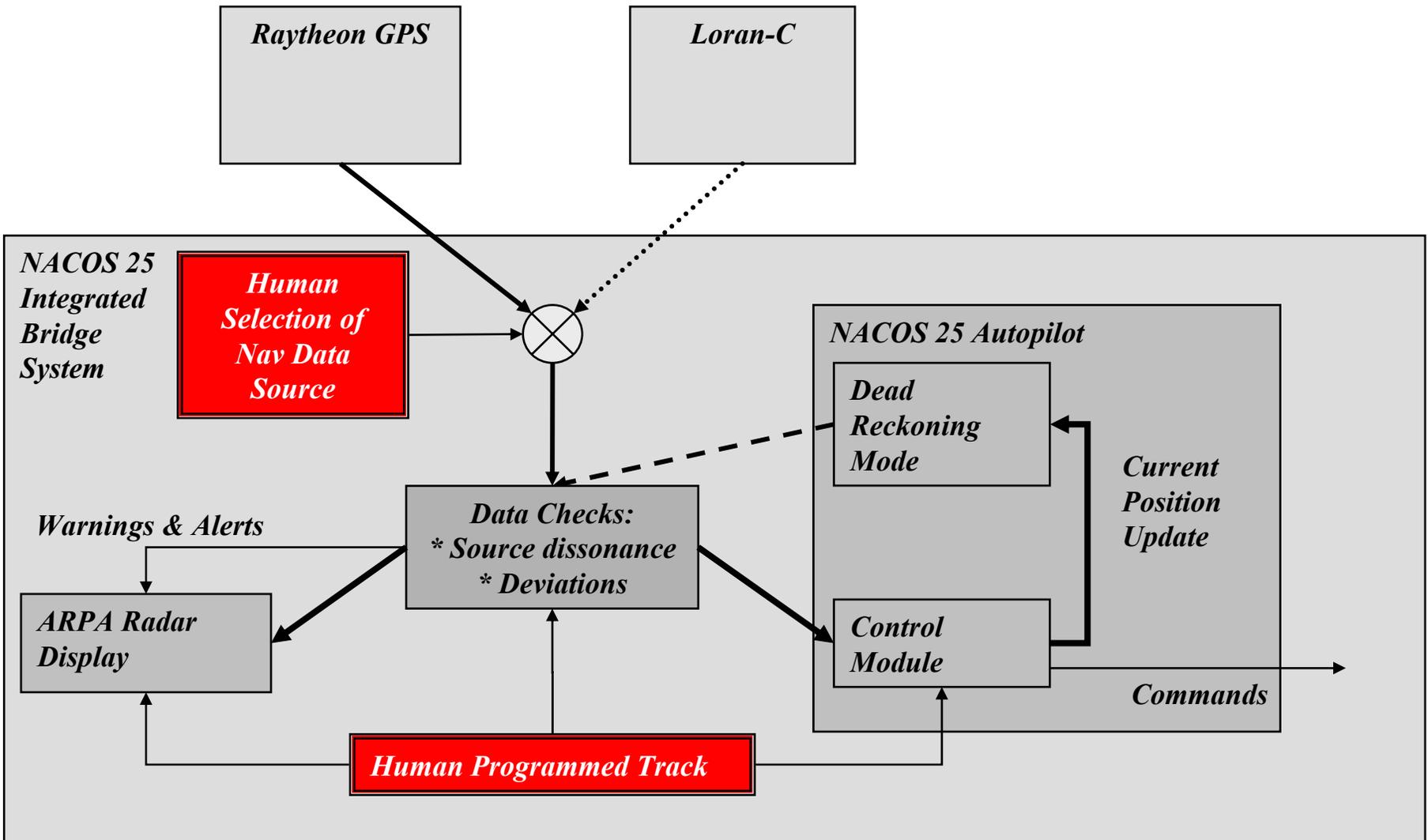




Key Supervisory Control Issues

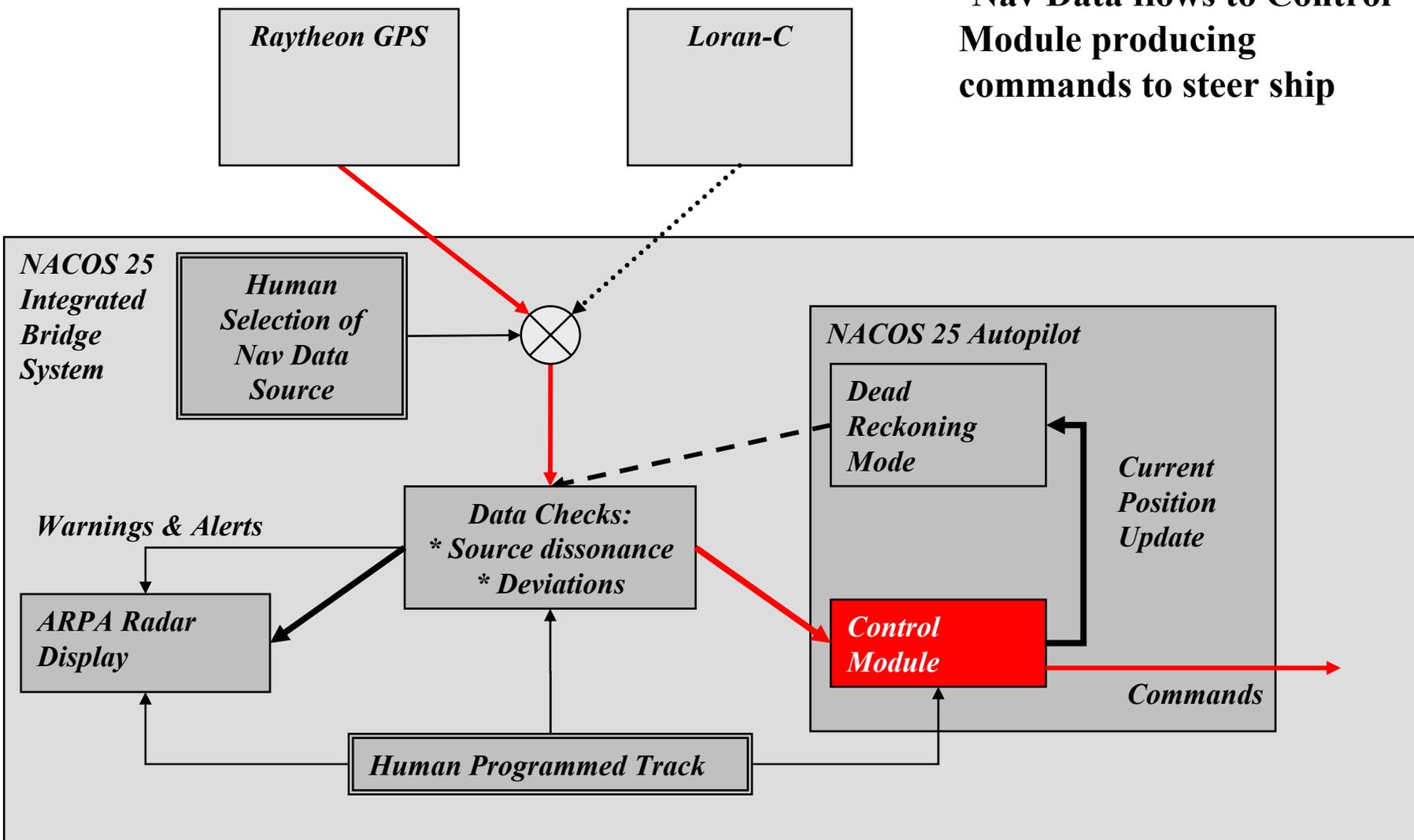
- **Monitoring automation performance and error detection**
 - Integrated bridge system could not detect problems with navigation data input
 - o Could only support and display a single data source
 - o Multiple sources (e.g. Loran-C) were available
- **Why weren't successive watch officers aware of growing navigation error?**

Integrated Bridge System



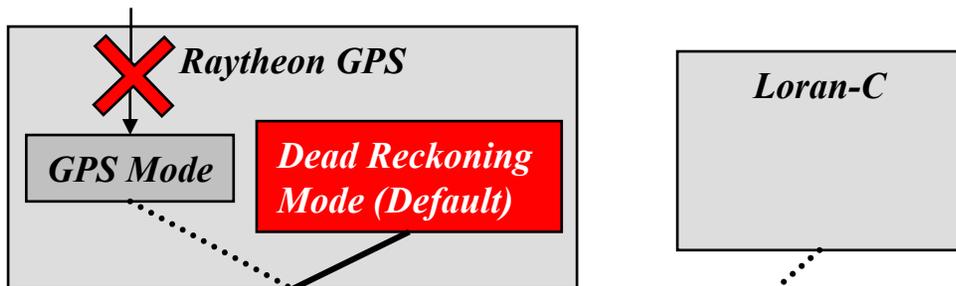
Nominal Information Flows in Integrated Bridge System

•Nav Data flows to Control Module producing commands to steer ship

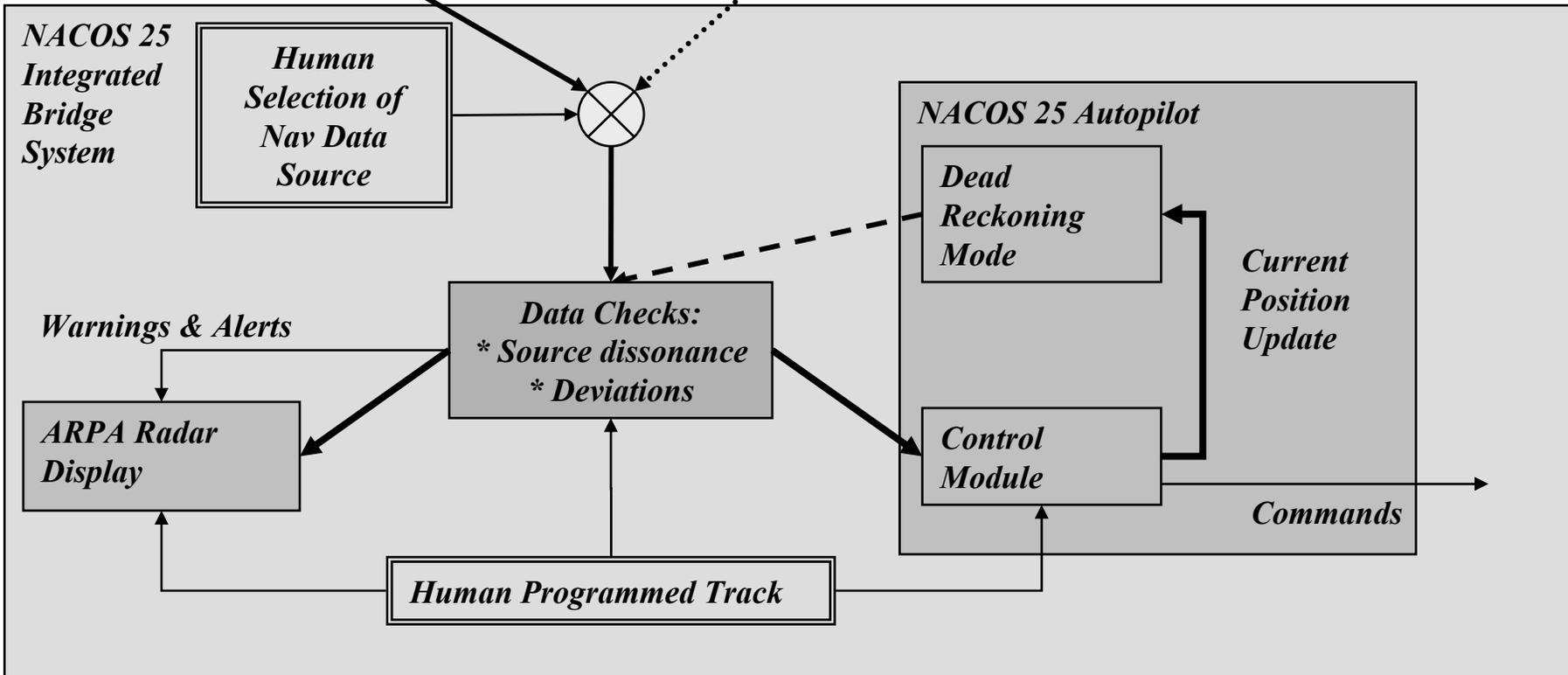


GPS Antenna Disconnected

GPS Antenna

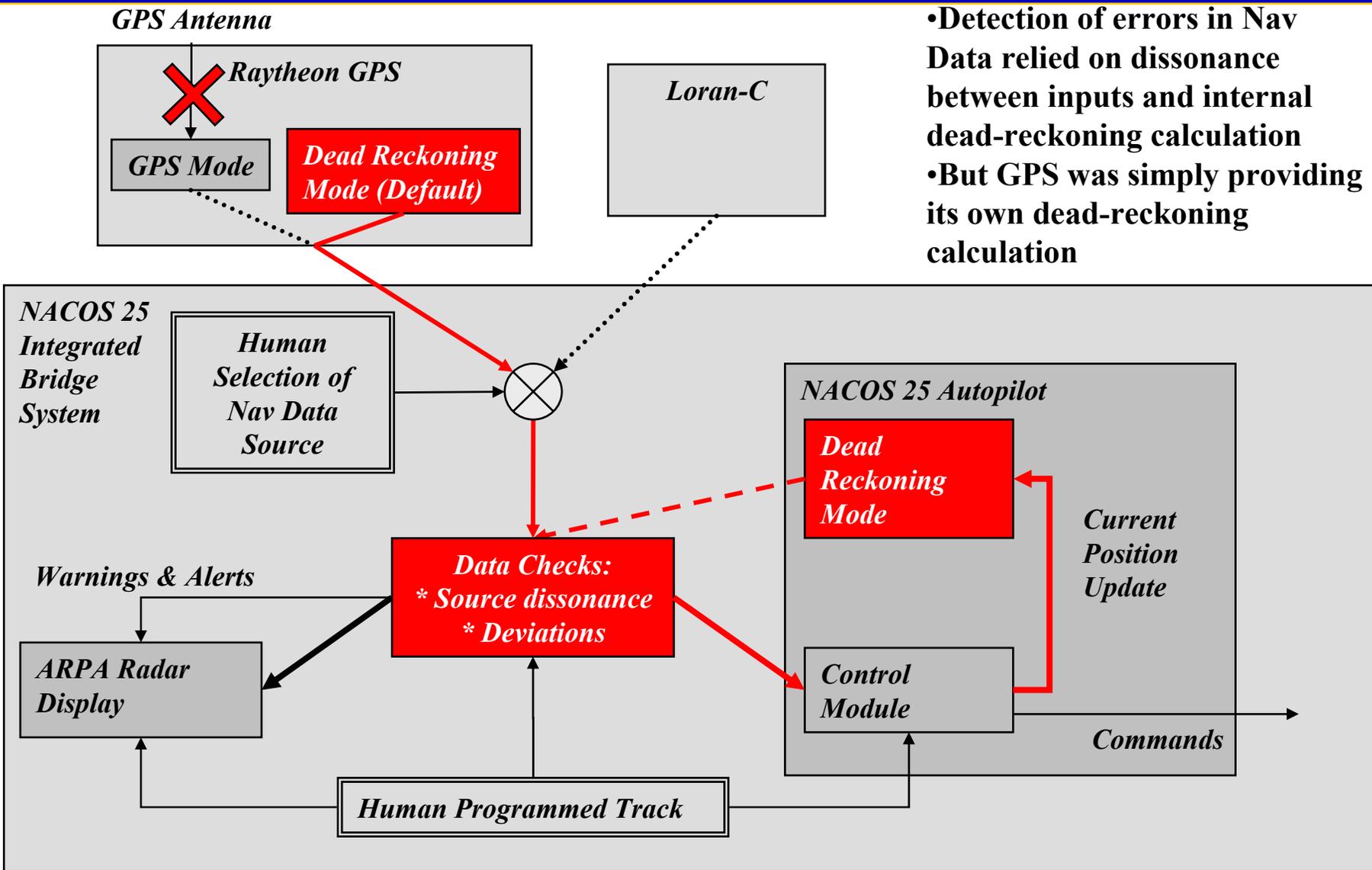


- GPS defaults into Dead-Reckoning Mode
- Feedback provided only on GPS unit (minimal)



Error Detection Relied on Comparison Between Two Similar Inputs

- Detection of errors in Nav Data relied on dissonance between inputs and internal dead-reckoning calculation
- But GPS was simply providing its own dead-reckoning calculation

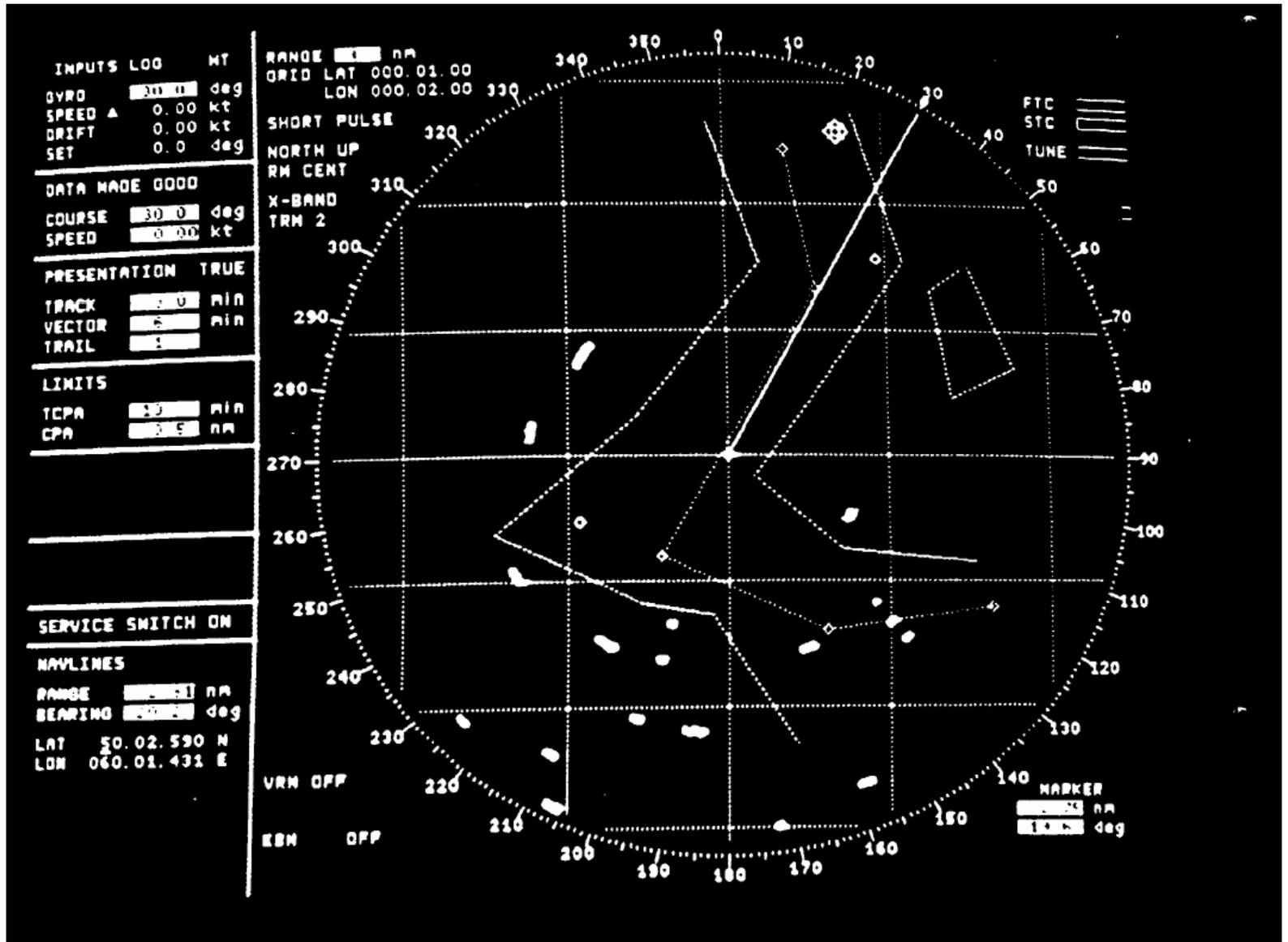




Key Supervisory Control Issues

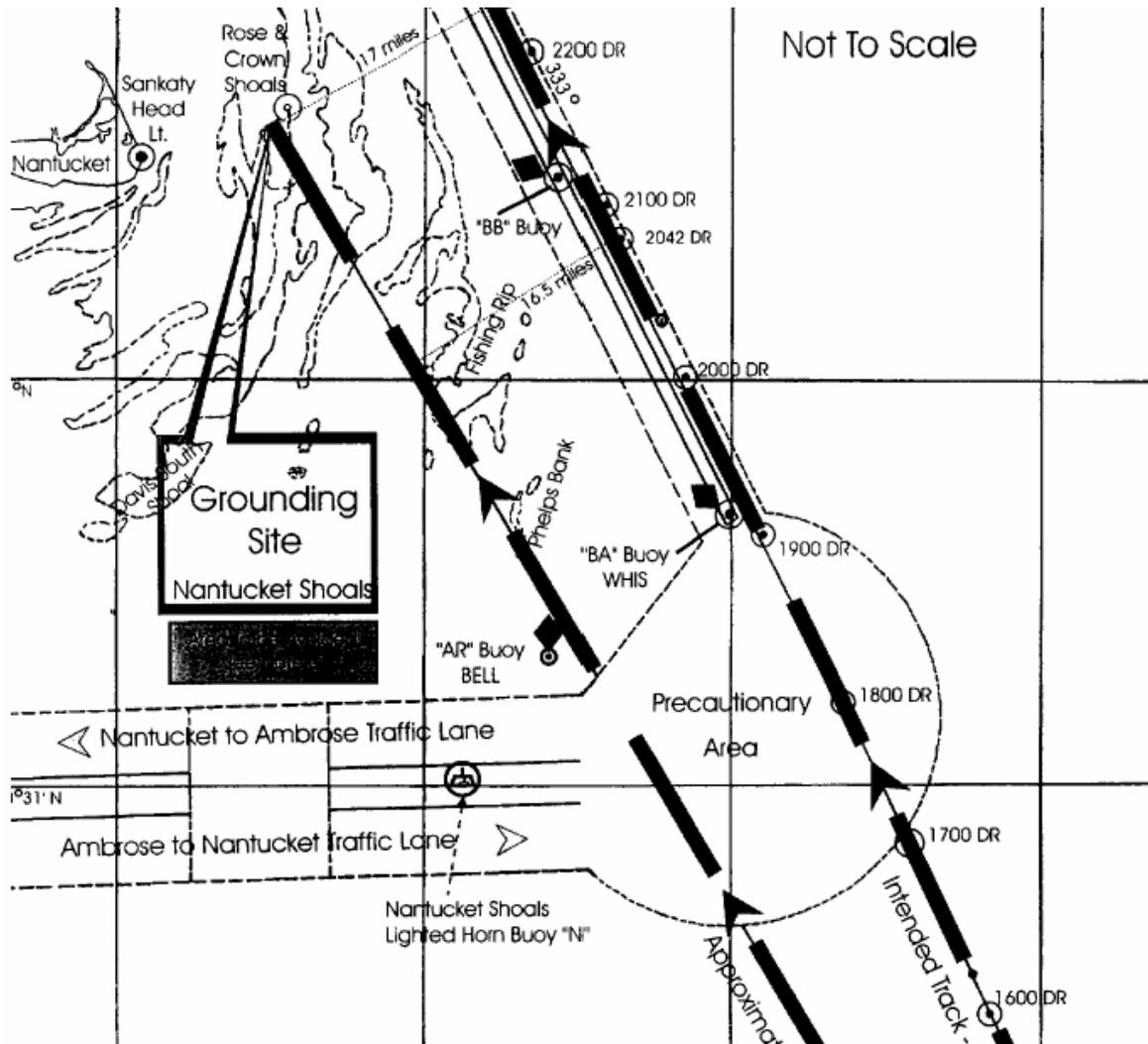
- Confirmation bias

Confirmation Bias: Radar Display



Picture from
NTSB report
PB97-916401

Missed Signs of Course Deviation



- Misidentification of navigation buoys
- Lookout spotted antenna lights, light blue water etc...
- Communication from fishing vessel in area
- Radar range settings too short to detect presence of Nantucket
- Fathometer alarm setting inappropriately set (0 m)

Picture from NTSB report PB97-916401



Key Supervisory Control Issues

- **Training**

- Most watch officers had received only 3 weeks on-the-job-instruction
 - o Not conducive to detecting and responding to non-nominal automation performance
- No officers (except navigator?) were knowledgeable about dead reckoning mode of GPS unit



Recommendations

- **Duplication of GPS and Loran Displays at Helm**
- **Critical mode changes highlighted with continuous alarms which require manual silencing**
- **Integrated bridge system should support multiple navigation data input**
 - Data consistency monitoring
- **Automation of fathometer**
 - Detection of out-of-harbor condition and reset

Questions



Picture from NTSB report PB97-916401