Opportunities for expanding shipboard-helicopter operational envelopes using modelling and simulation tools

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Outline

- Introduction and context
- Overview of simulation tools
- Discussion on leveraging the opportunity

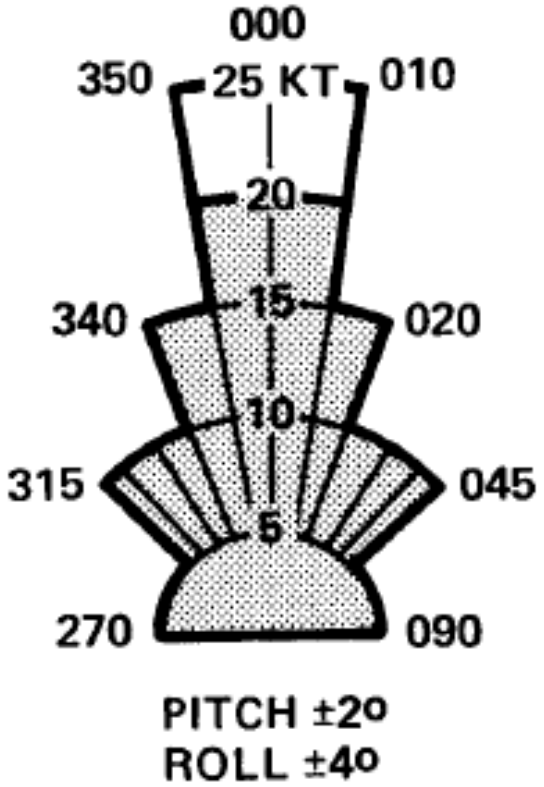
Context

- NATO nations operate helicopters in Sea State 6 (4 to 6 m significant wave height)
- M&S is being used to support safe flying activities
- M&S could be used more to support cross-deck operations

Cyclone helicopter landing on a Canadian HALIFAX-class frigate

The SHOL envelope

- Has wind limits (typically defined in 5 kt and 5 deg increments)
- Has motion limits
- Defined by at-sea testing
- Supported by M&S in most countries
- Defined by DIPES ratings



Generic SHOL envelope (AVT 217 final report)

Shipboard helicopter operations

environment
- day / night
- wind
- temp / pressure
- seaway

ship
- superstructure design
- hull design
- exhaust gases
- lighting / markings
- anemometers
- course / speed

conditions
- ship motion
- relative wind
- airwake
- cues
- sea spray / visibility
- aids / hauldown

aircraft
- aerodynamic loads
- control system response
- control limits
- engine performance
- mass / C of G

pilot response
- approach path
- hover position

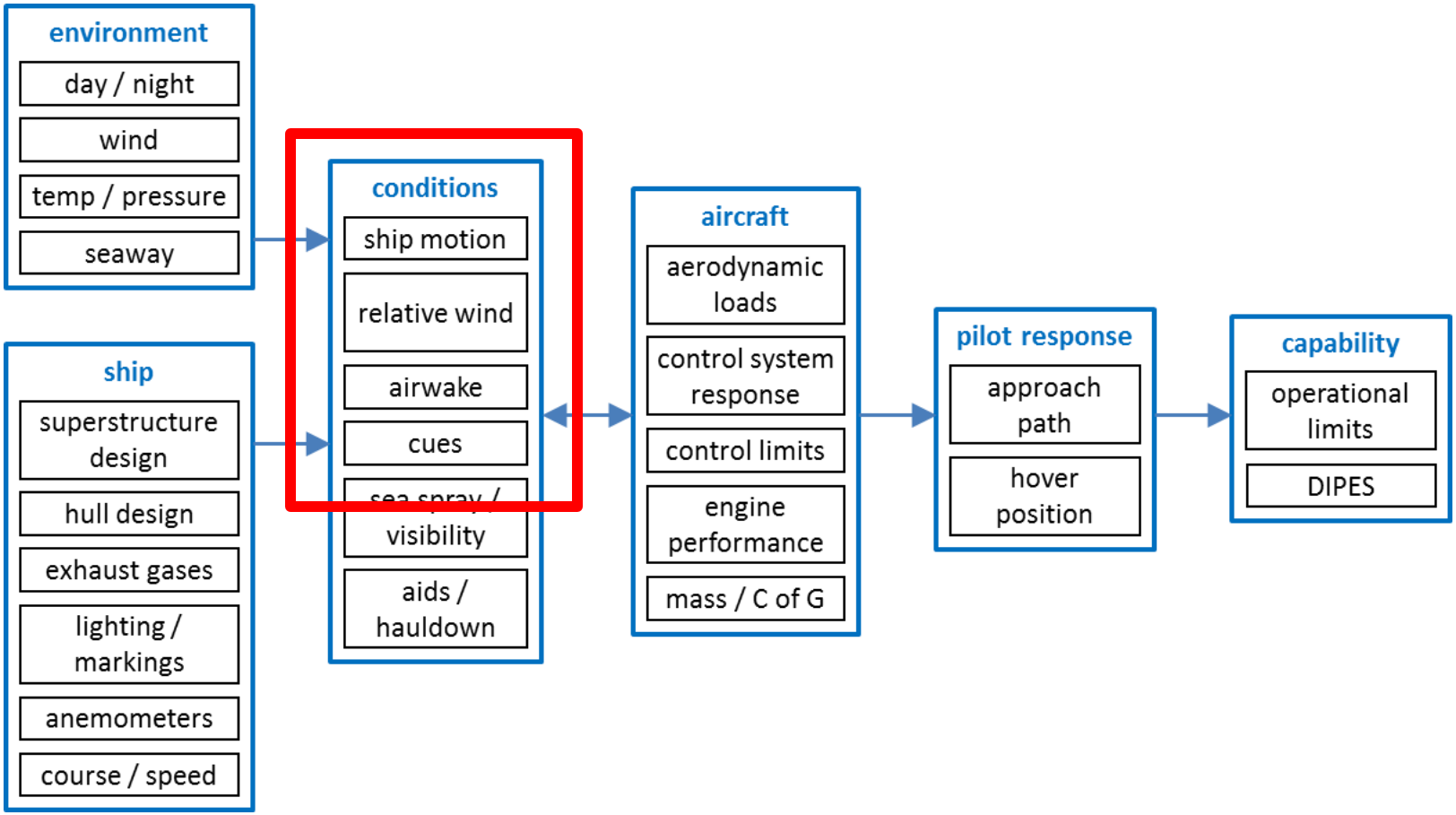
capability
- operational limits
- DIPES

Components of the ship-aircraft interface (SAI)

Cross-deck initiatives

- DIPES
  - standardized difficulty rating scale
  - may represent different difficulty levels depending on nation
- HOSTAC
  - contains standardized SHOL envelopes based on national envelopes or generic envelopes
  - standardizes for factors like deck markings
- Current M&S tools are not complimenting development of cross-deck envelopes

Improving cross-deck ops



Airwake modelling

- Many nations use airwake modelling to study shear layers, turbulence, and recirculation in typical ship airwakes and determine their effect on operations
- Airwakes are modelled experimentally and computationally
- NATO AVT 148 and 217 have documented current practices for airwake simulation

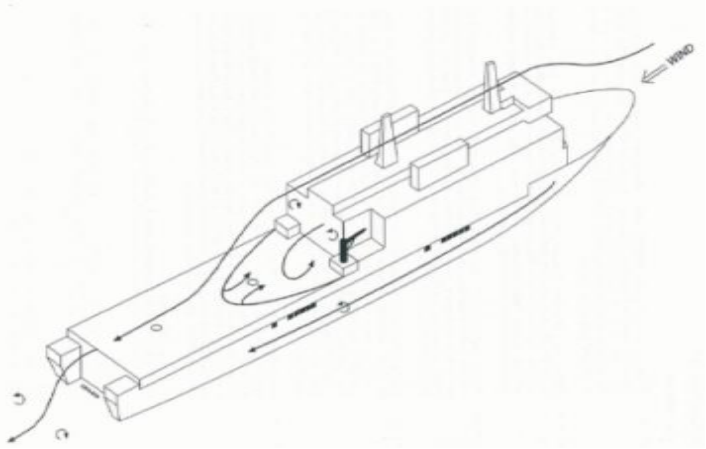
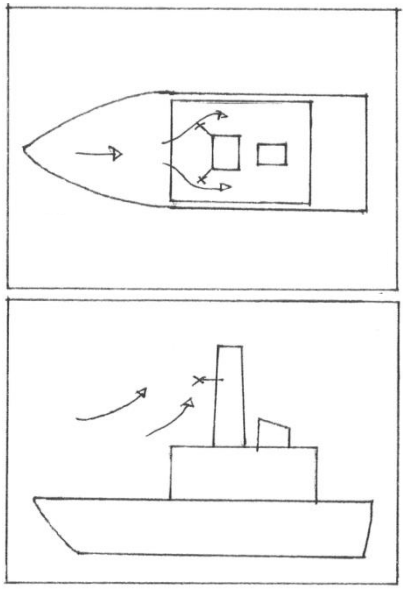


Illustration of airwake features (AVT 217 final report)

Relative wind

- Involves the assessment of prevailing wind conditions
- Prevailing wind conditions are strongly linked to ship airwake features
- Measurement of relative wind is subject to biases in speed and direction due to the presence of the ship
- SHOL envelopes are typically defined in increments of 5 degrees and 5 knots



Distortions to wind speed and direction at anemometer locations caused by the ship superstructure

Relative wind

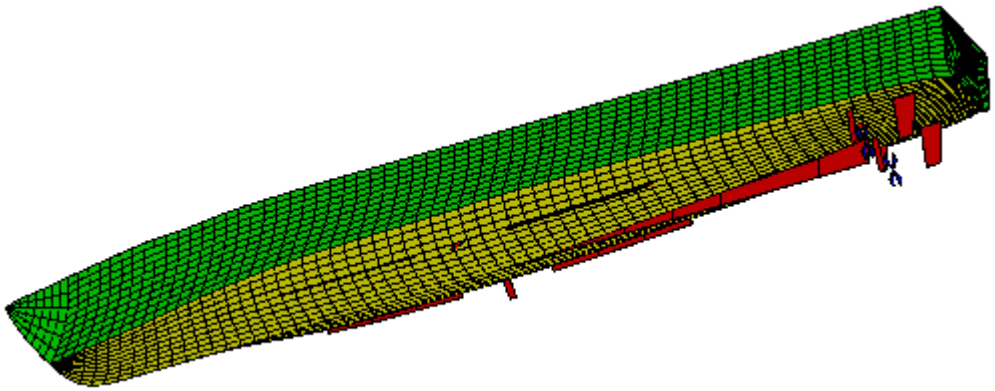
- Anemometer biases can be assessed using ship airwake simulation (computational or experimental)
- NATO AVT 217 has documented current practices in anemometer placement and bias management
- Many nations are considering or implementing shipboard bias correction

Relative wind: standardization opportunities

- Speed and direction quantity: 2D or 3D? Updrafts?
- Anemometer type: sonic or propeller/cup & vane? (Propeller vane can have dynamic uncertainties ~7 degrees)
- Alignment: incorrect alignment of 5 degrees is a full envelope increment
- Angle biases due to ship superstructure distortion: biases of over 10 degrees for reasonable anemometer placements are common
- Speed biases due to ship superstructure distortion: biases on the order of 5 knots (~20% at 25 knots) for reasonable anemometer placements are common
- Speed biases due to atmospheric boundary layer: biases on the order of 5 knots are common

Ship motion modelling

- Ship motion simulation is commonly used to calculate ship response to typical seaways and assess impact on operations
- NATO Subgroup 61 had published international standards on ship motion modelling

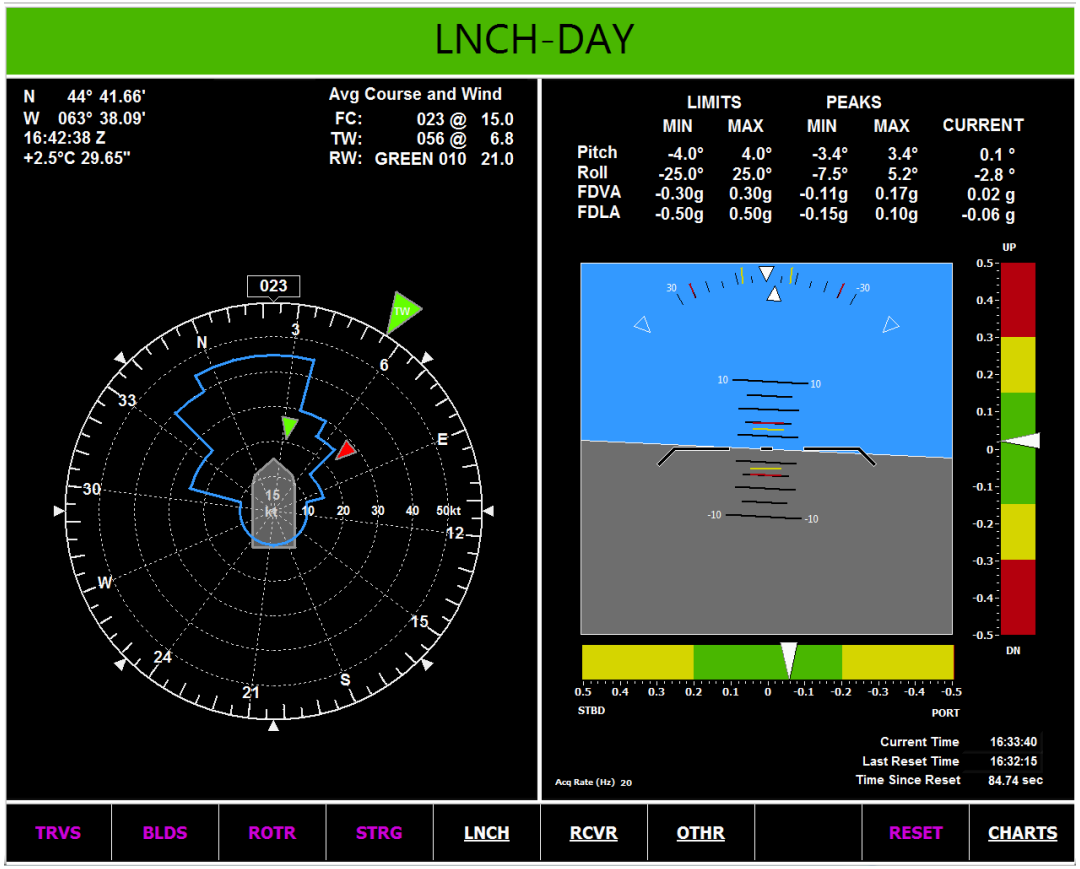


ShipMo3D ship motion model, including wet hull, dry hull, and appendages

Cueing systems

- Wind limits – allows easy identification of envelope wind limits
- Motion limits – allows easy identification of motion limits based on flight deck accelerations
- Operator guidance – rolls the limit information into a display that enables quick information integration and confident limit assessment thereby increasing confidence in operations

Cueing systems



Flight Deck Motions System (FDMS) Display

Incorporation of modelling tools for cross-deck operations

- Better knowledge of prevailing conditions can increase confidence in SHOL envelopes
- Simulation tools exist to give this knowledge

Incorporation of modelling tools for cross-deck operations

Do we:

- Incorporate this knowledge into standardized envelopes (required integration of simulation techniques into international initiatives like HOSTAC)

AND/OR

- Make standardized conditions information available to individual nations to inform cross-deck operations?