Production Technology Transfer and Demonstration for Large Composite Naval Vessels

National Shipbuilding Research Program
Product Design and Materials Technology Panel Meeting
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Acknowledgements

John Vonli, Umoe-Mandal
Glenn Eliassen, Umoe-Mandal

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Production Technology Transfer Agenda

- The Opportunity
- The Challenge
- A Blend of Skills and Experience
- The Technology Transfer Approach
  - Material Development
  - Technology Transfer Plan
  - The Results

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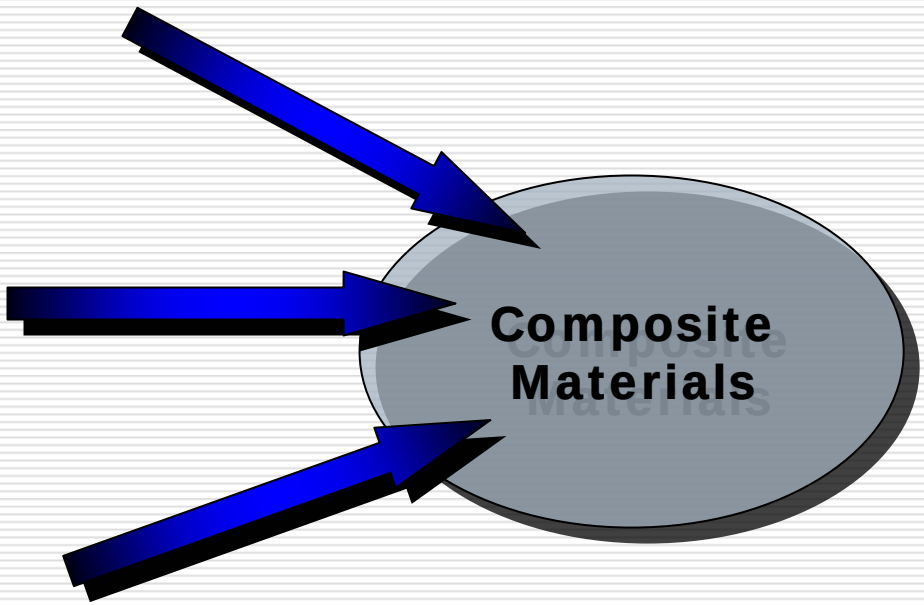
The Opportunity

24 knot ships do not support all future concepts of operation

- Higher speed will be necessary
  - *Increase installed power*
  - *Design high speed hull forms*
- Seakeeping
- Deck Area (modularity)
- New hull forms (non-traditional)
  - *Catamaran Swath*
  - *Tumble-home*
  - *Double "M" (Stiletto)*
  - *Surface Effect Ship*
- Lower costs
  - *Reduced crew size*
  - *Less maintenance*
  - *Increased Reliability*
- Signature Management
  - *RCS*
  - *Thermal*



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FRP - Sandwich offers

- Low weight
- High strength to weight ratio
- Excellent shock resistance
- Embedded stealth capability
- Integrated thermal insulation
- Structural design with reduced number of secondary stiffeners
- Simplifies construction
- Simplifies outfitting and aesthetic measures
- Reduced part count

The Challenges & Risks of a New Composite Ship

- Non-standard loads for non-traditional hulls (quality)
  - high speed
  - new missions/operations
  - Insufficient load prediction can lead to structural failure
  - Excessive Factors of Safety lead to heavy structures
- Be aware of Weaknesses of FRP-Sandwich
  - Avoid out of plane loading
  - Base material selection upon all required properties
  - Implement proper fabrication methods to produce effectively
- Long Development time (schedule)
  - Qualify new materials

The Challenges & Risks of New Composite Ship – cont'd

- Expensive (cost)
  - Raw Materials
  - Set-up time
  - Touch labor
  - Mold costs
- Repeatable fabrication process (quality)
  - Demonstrate new processes
- Durability (quality)
  - Fire, smoke and toxicity
  - Damage detection (quality)
  - Ease of repair (quality)
- True life cycle benefits (cost)

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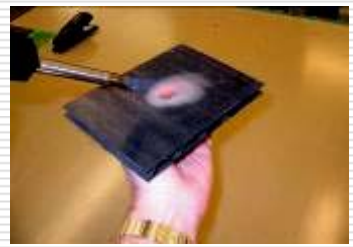
Goodrich – proven supplier of composite structures to US Navy

- Large Composite Structures
  - Sonar Bow Dome Acoustic Window
  - Sonar Keel Domes
  - Submarine Sonar Bow Domes
  - ASDS Exostructure
  - Various Large Prototype Structures
- Underwater Acoustic Treatments
  - Baffles
  - Coatings
  - Structural damping tiles
- Radar Absorbing Structures
  - LPD Louvers
  - Aerospace components
- Fire Protection Systems
  - Inorganic resins



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Umoe – World-Recognized shipbuilder (composite materials)

- Mine Countermeasure Vessels (Oksøy class) to the Royal Norwegian Navy
- Skjold-class Fast Patrol Boat
  - One Initial demonstration vessel
  - Five Skjold-class series vessels, due for delivery ‘06-’09
- Civilian rescue vessel
- High performance composite parts
  - centrifugal lifting fans
  - gun shields
  - towed bodies for mine sweeping purposes

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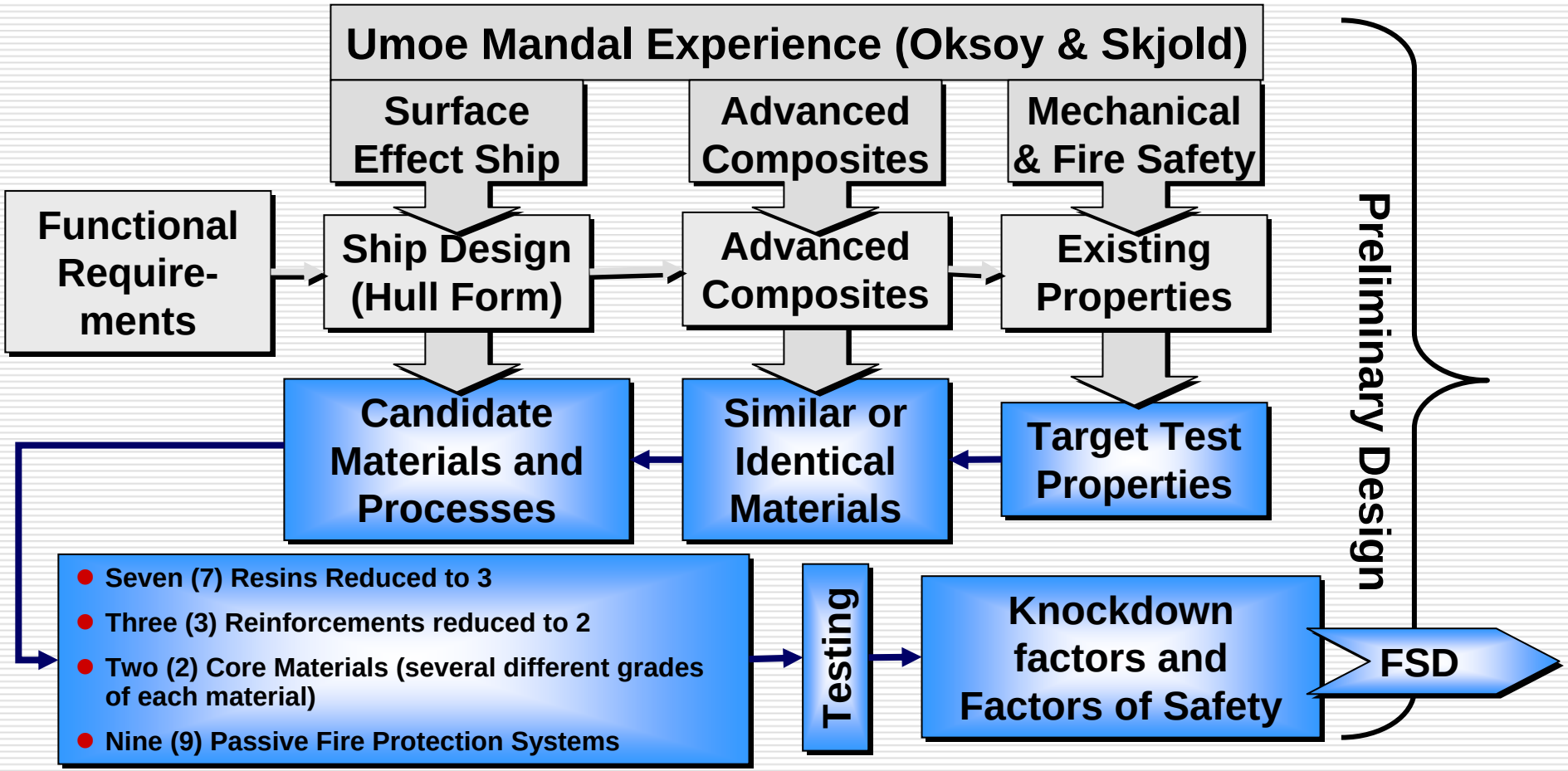
Material Development Process Leveraged Experience & Capitalized on Skills



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Continued to Assess Risks

- Capacity for Rate Production
- Material Quality (Repeatability)
- Workforce Training

Established Technology Transfer Plan to Mitigate Risks

- Traveled to Umoe to witness and participate in operations
- Refined fabrication processes by incorporating lessons learned
- Established training curriculum for workforce training
- Formulated a Risk Mitigation Demonstration Article

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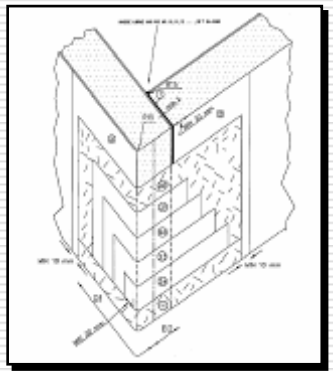
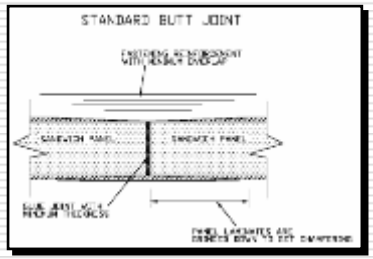
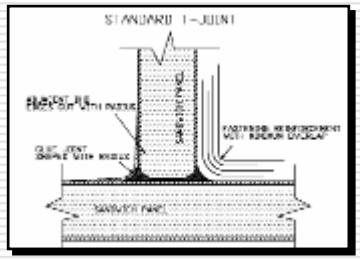
Technology Transfer at Umoe







- On site visit at Umoe and working meetings
- Refined Training Curriculum
- Transfer work package format and requirements

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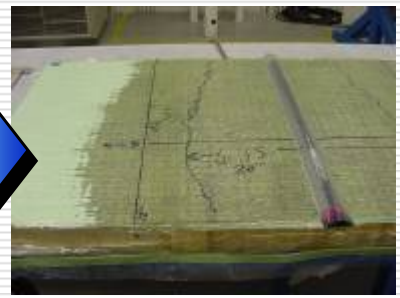
Production Process Risk Mitigation

Set up large infusion panel

Validated Lay Up Time

Validated Infusion Time



Results

- Confirmed reliable lay up rates in support of the production plan
- Confirmed material properties in support of ship design efforts
- Confirmed weight estimates on large panels (3M x3M)
  - (initial panel weights 2-3% heavier than plan)
- Conducted thorough investigation of over weight scenario

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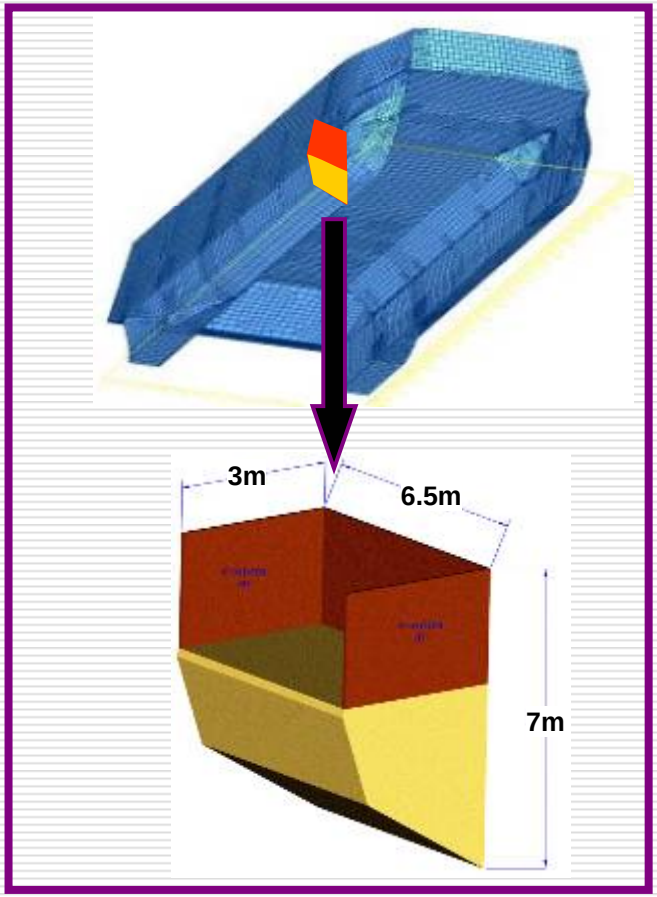
Risk Mitigation Demonstration Article (RMDA)

- Selected a 6.5m X 7m X 3m section of the lower hull.
- The selection incorporated all material types (fabrics, cores and resins) and all joining and fabrication methods
- Intended to answer the question: “Can steel ship builders make composite ships?”

  And

- “Is performance of product repeatable?”



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Training & Demonstration

- Each RMDA team member received 40 hours of introductory composites training
- And 100 hours of fabrication training
- The team then fabricated over 4,000 sqft of panels
- ~15,000 lbs





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RMDA Representative of Basic Ship Features

- 4 Resin systems, 5 Fabric types, 5 core materials, 2 Adhesives
- Butt Splicing, T-joints and Corner Joints
- Beam and Gusset Installations
- Bulkhead Penetrations
- Foundation Installations, Flange Capping
- Panels joined in downhand and overhead positions






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Risk Mitigation Demonstration Article

- 25+ large panels laid up
- 150+ validation metrics
- Increased confidence in training methods
- Fewer workers will be required per cell
- Supervisory needs will be less than first planned
- Team LCS works well together
- Design file exchange systems work
- Technical exchange process is solid
- Steel ship builders have few problems adapting to composites






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Conclusion

- Realistic Risk Assessment is Necessary
- Acceptance Criteria must be Established
- Typical Shipyards will be able to adopt Composite Fabrication Processes
- A Logical Technology Development (Transfer) Plan Reduces Risk

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