Lessons Learned from a Career in Ship Design-

Peter A. Gale
pagale@yahoo.com
301-384-3995

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Introduction

- Lessons for ship design excellence
- Focus: “Hands on” ship design development
  - Naval Architect’s perspective
  - Early stage design- up through CD
  - Major naval ship

Outline

1. People
2. Team
3. Data
4. Tools
5. Plan
6. Requirements
7. Process
8. Conclusions

1. People

- Skilled personnel: the most important element
- Full range of disciplines
- Extensive “hands on” design experience
- Experience in a construction yard and on ships at sea
- Continuing education
- Professional Society participation
- Apprentices must be mentored and their work reviewed
- “Designers” (were draftsmen) should play a key role in each new design

Toyota Excellence

- “Perhaps most important, Toyota has unusual engineering expertise. Toyota engineers serve a minimum of fifteen years before reaching management positions, have extensive hands-on experience, undergo frequent training, and are vigorously encouraged to think about their jobs and technologies by managers who are themselves technical experts.”
- From, “The Second Toyota Paradox: How Delaying Decisions Can Make Better Cars Faster”, by Ward, Liker, Cristiano and Sobek, Sloan Management Review, Spring 1995, pg. 60

2. Team

- Required skills:
  - Concept design: ability to visualize, synthesize and analyze innovative total ship concepts with support from functional area experts
  - PD and CD: strong team leader, combat systems eng’rs and ship design integrators, full spectrum of design disciplines
- Typical functional area team: one master, 3 journeymen, 2 apprentices
- Effective personnel management
- Core team members must be dedicated (full-time)
- Collocate the core team
- Team training is essential (for an untested team)

3. Data

- Provide the design team with all relevant data
- Data required:
  - Technical data on similar US and foreign ships
  - Technical Design Histories
  - US and foreign technology developments
  - Lessons learned from recent design projects (process and products)
  - Feedback from the shipbuilders
  - INSURV and fleet feedback
  - Design standards, criteria and standard design details
- Maintain the corporate memory for ship design:
  - Continuing data collection and analysis
  - Maintenance/updates of design standards/criteria

4. Tools

- Ship designers must know their software:
  - Validation
  - Testing the software in a variety of practical situations
  - Continuous practice needed to maintain skills
- Software “tuning” and continuous maintenance is required
- Improved tools for early stage design are needed:
  - Manning estimates
  - HSI trade-offs (people vs. automation)
  - More objective methods for effectiveness evaluation
  - Weight-based cost estimates lead to too-tight ships
  - Important risks are underestimated or ignored
- More sophisticated computer programs don’t save time

5. Plan

- Plan effort before starting design phase
- Work Task Assignments (WTAs) are needed
- “Lean” teams enhance productivity
- Keep the plan simple
- Plan and prioritize trade-off studies
- Don’t overdue re-planning during a design phase

6. Requirements

- The ship designers and the customer/warfighters must collaborate on defining requirements
- Educate the customer on req’ts likely to be important to him
- Identify the design drivers and locate the knees in the performance-cost curves
- Don’t let the customer dictate designer issues
- Avoid req’ts that can’t be demonstrated
- Late changes in requirements do occur

J. Scott Russell Quote

- “I must beg, however, to enforce on the naval gentlemen of this Society the necessity, not only of telling us so exactly what it is that they do want, that we may know what to set about providing for them, but also of *adjusting their wishes and demands to that which is really possible*. All practical naval constructors will agree with me in saying that it is too common for their masters and mine to simply ask for impossibilities. An admiral with authority proportioned to his rank will require you to construct for him a ship which shall be fast. You prepare a design, and he exclaims, that will never do; you have made her so long that she will never steer; he demands 13 knots and refuses you 250 feet of length; he requires that she shall stand up like a church, and refuses the tonnage of the large beam necessary to keep her upright; he urges the use of high power for speed, and refuses length of body to carry your boilers; he demands coals for a great many days, and limits you to a draught of water…”

» (continued)

J. Scott Russell Quote (Cont'd)

- "that won't carry it; he asks for a ship that will be as handy as a boat, and as quick as a cutter, and refuses you breadth of rudder and length of tiller, or turns of the wheel, to give you the sufficient purchase; he asks for a steady ship, and gives you such top-weight as makes her stagger. These are some of the causes which lead to bad ships, and to worse understandings between builders and users of them. Difficulties of this kind are only to be got over, in the end, by being conquered in the beginning. The fighter of the ship and her builder must come to a thorough understanding at the outset, and I trust it may be one of the useful results of such a meeting as this, that the naval commander of a future fleet will let us thoroughly know what it is he wants; and we will tell him as thoroughly what it is that it is in our power, and within the limits of our professional skill. We will do everything for him but impossibilities, if he will be content with asking everything but impossibilities."
- From "On the Professional Problem Presented to Naval Architects in the Construction of Iron-Cased Vessels of War", by J. Scott Russell, Institution of Naval Architects, 1861 Spring Meetings

7. Process

- Conduct continuing exploratory design: develop innovative design concepts, train teams, mentor apprentices, explore advanced technology impacts, identify technology gaps, exercise new design tools
- Design is not sequential; the “design spiral” is a primer for NA 101
- During PD and CD, employ regular baseline updates
- Dedicate a few master NAs and CSEs to design integration during PD and CD

7. Process (cont'd)

- Hold frequent informal design reviews
- Strive to minimize the impacts of formal design reviews
- All designs are not equal: High-end ship design teams get more attention and direction from higher-ups
- Stand up for adequate margins
- The design team leaders and integrators should observe important hydro model tests

8. Conclusions

- Ship design is challenging and rewarding
- Designing a variety of ships makes for a wonderful career
- Jump at every chance to work on a ship design
- Work on data collection and tool development between designs
- Exploratory design and acquisition design offer different challenges and rewards- you need experience with both
- Don’t shy away from laboring “in the trenches” early in your career