Better Embedded System Software

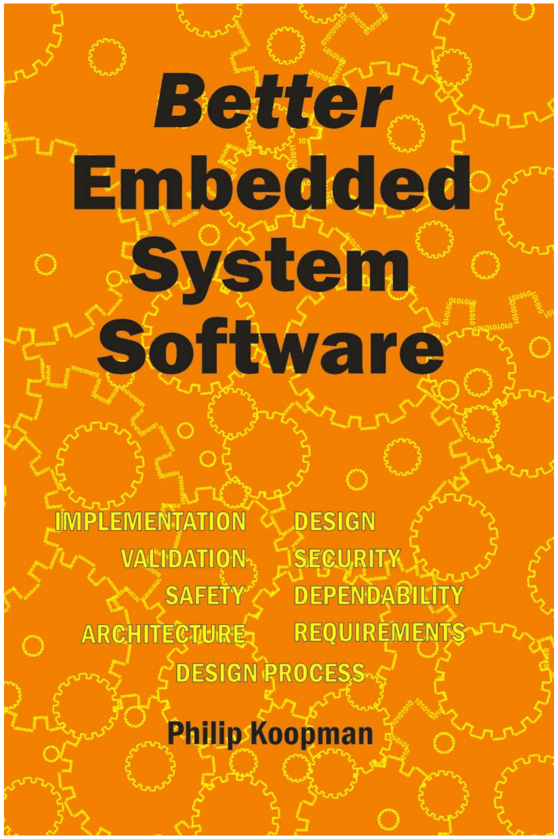
Philip Koopman

Electrical & Computer ENGINEERING

Carnegie Mellon University

Empirical Approach To Content

- **Based on 90+ industry design reviews**
  - Real companies, products, problems
  - Some reviews were to save failing projects
  - Other reviews were to check up on otherwise good projects
- **Professional book for practicing embedded system designers**
  - Dug out the “red flag” issues from the review reports
  - Sorted, aggregated, sifted
  - 6 areas; 29 topics within those areas
  - Each chapter is 8-15 pages about a red flag topic
  - This is the stuff designers get wrong in real projects
- Also see my blog at:
  http://betterembsw.blogspot.com/



Software Development Process

(Numbers are chapter numbers: 2-29)

2. **No Written Development Plan**
   - And, often, no defined methodical development process

3. **Insufficient paper trail**
   - Things other than the code itself not written down

4. **Creation of useless paper rather than useful paper**
   - Creation of paper for paper's sake (although this is unusual)
   - Belief that paper trail is a waste of time

Requirements & Architecture

5. **No written software requirements**
   - But often, thorough non-software requirements (digital HW, mechanical)
6. **Poor requirement quantification**
   - “Runs fast” or “user friendly”
7. **No traceability from requirements to acceptance test**
   - So you don’t know if the acceptance test actually tests everything that matters
8. **No non-functional requirements**
   - No stated targets for dependability, safety, security
9. **High requirements churn**
   - No change control process or formal change approvals; no freeze date
10. **No defined architecture**
    - Only a hardware-only block diagram
11. **Poor modularity**
    - Often just a big pile of code; multi-page Interrupt Service Routines

Design

12. **No software design**
    - Just implementation. Few flowcharts; usually no statecharts
13. **No statecharts for state-intensive systems**
    - Fuzzy understanding of behavior results in deeply nested, buggy "if" statements
14. **No real time scheduling**
    - Often ad hoc tasking approach
15. **No methodical approach to user interface**
    - Engineers take a shot without considering usability

Implementation

16. **Heavy use of assembly language**
    - Instead of writing code that is easy to compile or investing in good tools
17. **Inconsistent coding style**
    - Don’t use a style sheet or common style approach
18. **Optimizing for hardware instead of total system cost**
    - “Engineers are free” – spend time squeezing into the last 1% of memory
19. **Use of many global variables**
    - Some learned to program with unscoped languages (e.g., BASIC)
20. **No use of concurrency management**
    - E.g., no use of a mutex when warranted. In general no notion of time triggered

Verification & Validation

21. **Poor static checking or compiler warnings**
    - Warnings not generated or ignored
22. **Ineffective peer reviews**
    - Sometimes informal hall checks, but often nobody else even looks at code
23. **No test plan**
    - No methodical approach to testing. Often hardware-centric testing
24. **No formal issue tracking**
    - May not be a central bug log
25. **No run time error logs**
    - Or, sometimes, logs without enough useful information (e.g., no time stamps)

Critical System Properties

26. **Dependability**
    - Usually no dependability plan beyond “software shall never crash”
27. **Security**
    - Usually little or no security plan even for network-connected systems
28. **Safety**
    - Often no recognition that a system is somewhat safety critical (SIL 2 or SIL 3)
29. **No or improper use of watchdog timers**
    - Timers turned off or kicked from a hardware timer
30. **Insufficient attention to system reset**
    - May disrupt running system; may not anticipate multiple proximate resets