Software Quality Lessons from the Lockheed Martin Skunk Works

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Browsing the Web for some rationale to use in a Software Development and Quality Plan, I found a page (http://www.la.hodes.com/cm/lmsw/) with the Lockheed Martin Skunk Works Basic Operating Rules, also known as Kelly's Rules. The Lockheed Martin Skunk Works is an R&D facility that has earned a world wide reputation for great technical achievement and high productivity in the military aerospace field.

Although heavily slanted towards government aerospace contracting, the Rules embody many universal project management truths. I've interpreted these 14 guidelines for Software Project Development:

1. **The Skunk Works manager must be delegated practically complete control of his program in all aspects. He should report to a division president or higher.**

Translate this into matching authority with responsibility. The Quality organization, in particular, often suffers from the "responsibility without authority syndrome". Too often project managers are given great responsibility for the timely completion of projects without the authority to operate as they see fit. When someone is asked to take the risk, they must have the corresponding control to really accept the emotional strain such responsibility creates.

2. **Strong but small project offices must be provided both by the military and industry.**

This relates to the oversight function. Marketing is usually the closest analogy to a "project office" in commercial software development. Therefore, we can ask, "what is a strong marketing department?"

How about knowledgeable and decisive?

Too often marketing "requires" features they can't rationalize or justify. Unless they can point to some existence proof or demonstrate significant competitive advantage, they should allow engineering to proceed toward the earliest possible product so everyone can learn what works or is really required. (This was certainly the tactic in developing the P-80, the U.S.'s first operational jet fighter. It was the Skunk Work's founding project and completed in 80 days.)

Even a lack of specific technical knowledge isn't a fatal marketing flaw, especially in breakthrough product development. Bickering over details, however, can be. In such cases, the marketing group must be willing to defer to the technical approaches from engineering that take the straightest course to an initial product or prototype.

When specifically asked about a choice of alternatives, however, marketing must be willing to accept the responsibility of a definitive selection. At the same time everyone must recognize that occasionally specifications need redefinition and understand the consequences of such changes on schedule and ultimately, cost.

3. **The number of people having any connection with the project must be restricted in an almost vicious manner. Use a small number of good people (10 percent to 25 percent compared to the so-called normal systems).**

This is every much in line with Fred Brook's "Law" in the *Mythical Man-month*. It entails finding the maximum number of independent activities, and using something like a surgical team (i.e., Chief Programmer) approach on each, with a "Master Surgeon" to maintain conceptual integrity. Such project staffing seems to impart a universal benefit to productivity. (By the way, whatever happened to the Chief

Programmer concept? It seems that we need to absorb the wisdom of earlier methods into our latest thinking, e.g., objects and patterns. They are complimentary, not exclusive.)

4. **A very simple drawing and drawing release system with great flexibility for making changes must be provided.**

A note to start-ups: You will need to release something, so start planning for it early. The key here is that a design capture and production release system is still required, even in this most ad-hoc of design bureaus. A subtle point to also note: designs change!

Remember that the military aerospace bureaucracy was fully developed in 1947 when the Skunk Works was formed. It became worse as the technology in weapons systems outstripped the government's ability to oversee and control cost overruns that shocked the public (and continue to do so). If you think ISO9000 is draconian, at least you don't have to submit every drawing change to the customer! This rule proclaims the need for a *sensible* approach to tracking changes.

5. **There must be a minimum number of reports required, but important work must be recorded thoroughly.**

Here again we see the need for adequate records. A "skunk works" is ***not*** a license to run an undocumented project. A good early project activity it seems would be to decide what is *important*. Then make sure to capture this important work.

6. **There must be a monthly cost review covering not only what has been spent and committed but also projected costs to the conclusion of the program. Don't have the books ninety days late and don't surprise the customer with sudden overruns.**

Although framed in the context of government contracting, this rule is a call for collecting basic project metrics data. Reviewing this data monthly will calibrate the estimation techniques and start earning the project manager creditability with the resource providers. Even if there is cost growth, reporting it early and honestly is necessary to keep the first rule operative.

Tom Gilb, in his *Principles of Software Project Management* discusses controlling software projects for iterative estimating (section 16.5). Many of his principles fit right into several of these rules.

7. **The contractor must be delegated and must assume more than normal responsibility to get good vendor bids for subcontract on the project. Commercial bid procedures are very often better than military ones.**

This rule is fairly specific to government aerospace contracting practices: An aircraft is an aggregation of many parts, most of them purchased. Today's software is however, increasingly becoming like this as we exploit components and reuse. The buy versus make decision is complex. This rule demands cooperative and codependent contracts when buy is chosen,

8. **The inspection system, as currently used by ADP, which has been approved by both the Air Force and the Navy, meets the intent of existing military requirements and should be used on new projects. Push more basic inspection responsibility back to subcontractors and vendors. Don't duplicate so much inspection.**

This is one place that software may need to do more, before it can do less; because we're doing almost none of it now. When a buy decision is made, we often take the claims of the vendors on blind fate. Until the industry improves its overall quality, incoming (or at least pre-selection) testing should be as rigorous as possible. Once a vendor builds the necessary confidence, e.g., Rogue Wave's excellent Tools++ package, this rule can be applied.

Interestingly, ISO 9000 requirements for purchased component validation may cause more incoming inspection. Using ISO 9000 registered vendors, on the other hand, should allow wider application of this rule.

9. The contractor must be delegated the authority to test his final product in flight. He can and must test it in the initial stages. If he doesn't, he rapidly loses his competency to design other vehicles.

OK, so all the rules don't translate well. But the idea that testing provides feedback to product design argues for more (and better) testing by development. Throwing the product over-the-wall to a QA department is a close analogy to "contractor testing" as mentioned in the rule. If a development group doesn't understand the testing applied and the nature of the defects being discovered, it can't adjust its practices to prevent inserting these errors.

10. The specifications applying to the hardware must be agreed to in advance of contracting. The ADP practice of having a specification section stating clearly which important military specification items will not knowingly be complied with and reasons therefore is highly recommended.

Even in this highly accelerated development environment, the need for concrete specifications is acknowledged. It's the very urgency of these projects that makes clear specifications all the more important; no time can be wasted doing the unnecessary or wrong things. But what a radical idea: if you've decided to relax some standards, knowing which and why is important.

11. Funding program must be timely so that the contractor doesn't have to keep running to the bank to support government projects.

Tell this one to your Venture Capitalists. The early reporting rule (number 6 above) helps when you ask for this "open spigot". Also see the next, related rule.

12. There must be a mutual trust between the military project organization and the contractor with very close cooperation and liaison on a day-to-day basis. This cuts down misunderstanding and correspondence to an absolute minimum.

All projects have some resource provider. Just replace "military project organization" with venture capitalist, banker, Wall Street analyst or Board of Directors. Honesty is probably the key here. Two other rules of thumb for earning and maintaining trust are having many little "Visible Signs of Progress (VSPs)" and always having a working demo.

13. Access by outsiders to the project and its personnel must be strictly controlled by appropriate security measures.

Loose lips sink ships and start-ups. Engineers, especially those enthusiastic about their work, love to talk about it to anyone who'd listen. Although this rule was consistent with the Skunk Works' mission of producing highly secret military aircraft, it may be as important in this post-Cold War period of intense international commercial competition.

14. Because only a few people will be used in engineering and most other areas, ways must be provided to reward good performance by pay not based on the number of personnel supervised.

We're all aware of the golden pot of IPO stock options. The key point in this rule is to reward all, not just the managers. This rule may already be in effect fairly widely in the software industry. Dilbert aside, the rewards to top individual contributors are often the equal of or above those of their managers.

Notice also the qualification of "good performance". The feeling is that everyone in the classic skunk works scenario will recognize "good performance" from their peers and respect the distribution of rewards. This theme of the highly productive "jelled" or elite team also occurs in DeMarco and Lister's *Peopleware* and as early as 1971 in Gerald Weinbeg's *The Psychology of Computer Programming*.

Now a word of caution. This Skunk Works model has been adopted in many other design and manufacturing organizations but none have achieved the fame of the original. Does that mean there's more to it than these rules. Probably. It appears that Kelly Johnson (1910-1990) himself was a part of that equation. Perhaps a large part, as the Skunk Works has little to show in the "what have you done for me lately" department. (Even if you're a UFOlogist hanging out at Area 51, the current projects can't claim the cost effectiveness of the P-80 or U-2.)

But from reading Kelly's Rules , they still seem to be relevant and, with this transcription into the vernacular of Software Development and Quality, can be worthwhile considering in your next software development project.

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