INTRODUCTION

My time on the Space Shuttle program was relatively short, the last six years before the final flight in 2011. I was welcomed into the family nearly thirty years after the first flight, and I had the opportunity to learn more in those years than I ever could have expected. After the program ended, I sought to find a similar environment with good intelligent people doing profound things.

The similarities to the nuclear industry are numerous. Nuclear Power Plants, much like the Space Shuttles, were designed in the 1970s, running in the 1980s, and growing and improving since then – and some are facing decommissioning soon. Failure is not an option, and everyday things must run perfectly smooth because people’s lives and well-being are on the line. These organizations are high risk and safety critical where the benefits of operation outweigh the risk. They are both places where good people do things very well.

Of course there are differences as well, in technology and policy. In spaceflight, the worst case scenario is instantaneous. Mission success tends to be a pass or fail scenario. That means that planning becomes everything. You plan, practice, practice, and plan, and you only get one shot to launch smoothly. So you have contingency plans for everything, multiple landing sites around the world depending for multiple scenarios. In the event of an incident in a Nuclear Power Control room, all your planning must feed into action, but that action could run for hours, days or weeks. That adds an element of stress – and adherence to culture of operators - that is unknown to human spaceflight.

LESSONS LEARNED FROM THE SPACE INDUSTRY

The human spaceflight industry has a lot of lessons to learn. They had been running, improving and creating efficiencies in their processes for forty years, they were bound to be good at it by now, and they were. Rates of incident were lower than they ever had been, but as evidenced by the Columbia accident of 2002, some lessons from the 1986 Challenger accident [1] had been forgotten. “In both cases, engineers initially presented concerns as well as possible solutions… Management did not listen to what their engineers were telling them. Instead, rules and procedures took priority. [2]” According to the accident reports, many of the same contributing causes had occurred on both occasions, such as succumbing to schedule pressure, allowing management to pressure engineers, and following procedure and policy above common sense. Even a mere four years after the Columbia accident I saw evidence of some of these issues beginning again; and we were in full compliance of quality and training programs like Total Quality Management [3], Project Management Professional Guidelines [4], Lean Six Sigma [5], and the volumes of military and NASA specifications.

Our organization had matured into a very detailed oriented step-by-step based procedure-driven group. An instructional manual to install a door had morphed from a three step procedure into a hundred page document; complete with warnings including that drinking isopropyl alcohol is harmful to your health. At what point did we stop trusting our employees to not drink the isopropyl alcohol? It’s not that warnings do not have a place, hydrazine is not a pleasant chemical, but there lies a balance somewhere between the two extremes. Thus, this was something I set out to find, but for the Space Shuttle program, the problem ended up working itself out when they shut down the program. However, the more I read, and immerse myself in the nuclear industry, I see the same thing happening, but this time decommissioning may not be the answer.

“NASA’s culture of bureaucratic accountability emphasized chain of command, procedure, following the rules, and going by the book. While rules and procedures were essential for coordination, they had an unintended but negative effect. Allegiance to hierarchy and procedure had replaced deference to NASA engineers’ technical expertise” - [2] Columbia Accident Investigation Board.
This is an opportunity for the Nuclear Community to consider some of the things that the spaceflight industry was able to overcome, and take warning in the points that they were not. This list is a summary of some of the things I learned from working in the spaceflight industry, but there are many other lessons to be learned from other critical domains such as aviation, automobiles, or healthcare.

1. Hire good people, and then trust them to do the right thing.
2. Learn from your mistakes, but anticipate new ones.
3. Document everything – and then make sure the information is accessible to everyone.
4. Over communicate at every channel. It’s better to hear something twice then not at all.
5. An open door policy can save lives. NASA started the “Time-out” policy where any employee, at any point could stop any operation to raise concerns, ask for clarification or asks questions. Even the janitors could stop launch during the countdown if they had unease.
6. Over communicate from management to employees – through e-mails, newsletters, and employee meetings.
7. Take caution not to over burden people with signage or it will go unnoticed.
8. Rehearse, again and again, over and over. Then dress rehearse – no minor detail is to minor in a complex interrelated system. The harsher you are in the simulator, the easier actual incidents will be.
9. Schedule is never as important as doing the job right.
10. Company goals should be communicated often and clearly.
11. Often times, large problems can be solved with diverse focus groups of employees and one day of time.
12. Any metrics being measured should be defined, and communicated.
13. Sometimes it is cheaper to reuse hardware, and sometimes it is cheaper to replace it.
14. Decommissioning is emotional painful for anyone close to the system. Don’t underestimate the effects this has on morale.
15. You’re growing old. Your organization is growing older, as you rise in the ranks of management; trust your engineers and operators. The average age in the Apollo Control room the day we landed on the moon was 26.
16. The community should help support the community. We had an optional program in place where we could auto deduct a dollar or two from our paychecks to a community fund. While this fund generally funded local charities, we were able to change lives for our coworkers in Houston after a hurricane.
17. Moral events and social opportunities help to build stronger teams. Sometimes what looks unproductive is an exercise in building trust.
18. Sometimes more systems for control and more reports are not the answer. Information overload can often be worse than not having enough information.
19. The importance of written requirements cannot be overstated. This includes the intent for these requirements.
20. Incorrectly incorporated requirements can cause mission failures [7].
21. Antiquated analog technology has its place, it’s proven and it works. Technology for the novelty of technology can do nothing but complicate things.
22. The next generation will not think the same way you do. They don’t have the same culture, but they do have good ideas, so listen to them.
23. Every meeting should start with a safety message. It fosters a culture.
24. When hiring, focus on personality and integrity, and train them with the knowledge required to do the right thing.
25. Never reach a point where you award people for making mistakes. They should have the integrity to report mistakes; you should foster a culture where they do not fear repercussion, but without awards intended to encourage disclosure.
26. People naturally gravitate towards common groups. Some of these groups require autonomy, some require micro managing. A skilled leader is one who knows the difference.
27. Motivation is built on autonomy, mastery and purpose [6]. Incorporate these concepts into your training programs.
28. Multiple choice testing is rarely indicative of an in-depth understanding of a system.
29. Question the rationale for your rules, procedures and decisions often.
30. Sometimes an employee does not fit the job role they are in, and vice-versa. That does not mean they are not a perfect fit for a role elsewhere. Work with your strengths and compensate for your weaknesses.
While not all of these lessons may be applicable, they are considerations for the future, simply observations from another high risk domain. Additional research is being done at the Human Centered Design Institute at Florida Institute of Technology to look at how maturing organizations and strict adherence to policy and procedure are affecting the nuclear industry as a whole [3]. We are trying to find the balance in procedures vs. skill that the Space Shuttle program did not have the opportunity to.

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REFERENCES