

# An imagineering approach to the future of space situational awareness

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## ABSTRACT

It is widely accepted that space is becoming a more congested, contested, and competitive domain. This drives a need not only to track space objects but also to have a clear and constant picture of what the objects are and how they are being operated.

Space situational awareness, like most mission areas, suffers from the need to maintain aging, increasingly fragile legacy infrastructure and at the same time acquire increasingly complex materiel solutions that often fall behind schedule and over budget. Imagineering, the name for both the process by which Disney creates new theme park experiences and the corporate division that does the work, offers some new ways of thinking about balancing these needs and providing better bang-for-the-buck.

Through a series of personal anecdotes that illustrate key concepts of Imagineering, this paper supports a conclusion that a new way of thinking about the space situational awareness mission area will be needed to ensure mission success moving forward.

## 1. INTRODUCTION

Imagination and engineering. A harmonious blending of creative thinking with physical design that makes things real. Walt Disney trademarked the portmanteau *Imagineering* in 1967, renaming WED Enterprises—his arm of the company that designed and built immersive theme park experiences starting with the original Disneyland in 1955. Today, Walt Disney Imagineering (WDI) oversees creative development and construction at six theme park sites around the world in addition to cruise ships, off-site resorts, and myriad other projects for The Walt Disney Company. The group proudly claims that there are at least 140 disciplines that make up Imagineering, everything from artists, architects, engineers, writers, machinists, landscape designers, model makers, sound technicians, carpenters, producers, accountants, filmmakers, schedulers, estimators and many more.

What does this have to do with space situational awareness (SSA) or the challenges we face in this mission area? Hopefully by the end of this paper, you'll agree with me—quite a lot. I've spent 21 years in various capacities working to create and improve space control systems, and recently 3 years as an Imagineer creating and building theme park attractions. I saw many parallels, and think some of the lessons I learned at Disney can illustrate both the challenges we face in terms of SSA and how to overcome them. Are you ready? Please keep your arms, hands, feet and legs inside the paper at all times, because this here's going to be the wildest presentation at the AMOS Conference!

## 2. WHAT IS IMAGINEERING?

The way Disney comes up with all of its theme park and resort offerings is different from other companies in the themed entertainment business. In fact, sometimes when asked how they compare themselves to their competitors, Disney claims they *have no competitors*—the level of detail, quality, theming, and story that goes into everything they produce results in a unique product different from any traditional amusement park ride, themed hotel, or fireworks show.

There's no denying that Disney is the world's leader in producing highly-themed, immersive environments for families to enjoy together. And they have established both an organization and a process, both called "Imagineering", that generally comes up with impressive results that both build the brand's reputation in the marketplace and the company's bottom line.

Without getting into anything proprietary, new projects at WDI start from one of three sources: a business need, an irresistible creative idea, or a gleam in a top executive's eye. Far and away, most of them start with a business need, something like a demographic projection that a resort will need 1,000 additional hotel rooms by a certain date to accommodate expected demand, at a certain price point, and featuring certain amenities. Other times the business need can be driven by guest feedback, for instance that a particular theme park doesn't have enough live entertainment experiences, or that a dated attraction's storyline no longer resonates with current audiences. In cases like this, a business case is drawn up that leads to an acceptable budget to meet the need, and the Imagineers get to work coming up with all kinds of crazy ideas, eventually converging on something both creatively compelling and within the allocated cost target.

One thing that sets Disney projects apart is a focus on story. Once a creative concept is chosen, a rich tapestry is woven to tell the tale of the experience. These stories are then used to help hold the concept together so that everything from font choices on graphical signs to the background music, architectural details and paint finishes on ride vehicles, help support that narrative.

Another differentiator is attention to detail. While other theme parks have developed immersive lands in recent years, even they do not go to the lengths Disney does to ensure every aspect of the guests' experience is considered. All five senses must be taken into account, and nothing that distracts from the experience at hand should intrude. Millions of people remember the first time they walked down Main Street, USA (whether in Anaheim, Orlando, Tokyo, Paris, or Hong Kong) and how *complete* the experience was. The architecture and signage, the look and sound of the vehicles, the rollicking ragtime music, even the smell of freshly-baked chocolate chip cookies wafting from a storefront... all of these things combine harmoniously (and usually subconsciously) to help the guest leave the worries of the present day behind them at the gate. We feel *transported* to another time and place, and no one does that better than Disney.

The most recent example of this type of immersion is Pandora, the newest land at Disney's Animal Kingdom park in Orlando. Here guests are taken to a distant planet just by walking a few steps from other lands themed after Asia and Africa, and the experience is so convincing to almost be magical. It features floating mountains, otherworldly bioluminescent flora, and a startlingly convincing simulated ride on the back of a giant winged beast. So how does such a project move from concept to construction?

### 3. PHASES OF AN IMAGINEERED PROJECT

All Disney projects start in the Blue Sky phase, so-named because "the sky is the limit" in terms of what can be dreamed up. There are few constraints on thinking in this phase, the idea being that allowing wildly creative people to synergize their thoughts and ideas will result in a superior product to what anyone could alone. It's like brainstorming on steroids.

But notice I said "few constraints", not "no constraints". Completely unconstrained thinking would lack focus and fail to result in any kind of cohesive product. With Pandora, Blue Sky thinking started with the understanding that Disney's Animal Kingdom needed expansion, both geographically (to be able to comfortably hold more people) and temporally (to be able to provide a sufficient number of compelling experiences for guests to want to spend more time there). Disney's Animal Kingdom shares values of exploration, conservation, and nature, so the new project needed to be consistent with those. The company wanted to form a strategic partnership with a known intellectual property that would both be familiar to guests and offer the opportunity to amaze them, so a deal was struck with James Cameron, the creator and director of Avatar. Finally, a target budget was established based on the projected annual revenue such a project would generate and an acceptable amount of time for the project to break even financially.

With those constraints (expansion, consistent with values, tied to Avatar, and a target budget), the fun process of Blue Sky began. It's not uncommon for projects to remain in Blue Sky for months or even years, but in this case an additional constraint was placed on the team—a target opening date. In about a year, the team had to nail down the attraction, dining, and retail mix, come up with fantastic (yet buildable) concept art, establish the backstory, and

have enough detail that an early yet high-confidence cost estimate could be developed to show the project was ready to advance. Disney calls this Gate One, and it's when a project's capital expenditure is first approved.

Now additional Imagineers were added to the team with the task of turning the concept art into reality. Architects, engineers (mechanical, electrical, civil, structural, and more), ride system designers, show specialists (lighting, sound, set piece, color and paint, special effects, media, animated figures, etc.), and construction experts got to work converging on a series of increasingly-detailed drawing packages. These started as concept drawings, then advanced to feasibility, schematic, design development, and finally construction drawings. Along the way, two additional project reviews (Gates Two and Three) ensured top leadership was on board with the project. Early on, contractors were added to the team to do much of the hard-core architectural design and the actual construction.

Disney employs each of the two models that are commonly used in construction, design/build and design/bid/build. With design/build, a single company is brought on early in the project to assist in the development through the various phases. This is also the company that will be doing the construction (at least as the general contractor), so they have a vested interest in making sure what they design can actually be built. The drawback can be that design/build companies typically do not have many types of specialized architects and designers on staff. Disney projects, as you might imagine, are tremendously complex and each one is unique. Many firms that do a fine job building hospitals, schools, and hotels (which can be complex but, by comparison, are fairly cookie-cutter projects) struggle with the countless unique demands of a Disney project.

In a design/bid/build project, an architecture/engineering firm is brought on to supplement the Imagineering staff during the design phase. Once the drawings are at the intended level of maturity, a competition is held to select the general contractor who will build the project. By this point in the project there is more certainty and therefore more ability to estimate the project scope to a higher level of fidelity. It is even possible to bid the construction part of the project as a fixed-price effort, although this is rarely done on Disney projects due to the high level of complexity and often change that occurs later in the process. One drawback to the design/bid/build approach is that different companies have done the designing and the building, potentially leading to friction and miscommunication.

Both approaches have worked for Disney in the past, and both have led to projects that performed wonderfully and others that struggled. But, by Disney's own definition, none has ever been a failure.

#### **4. IMAGINEERING SUCCESSES AND “SUCCESSFUL FAILURES”**

Part of the culture at Walt Disney Imagineering is to learn from poor-performing projects; there is no such thing as simply a “failure”, but instead the term “successful failure” is used to denote that *every* project offers lessons, content, and learning that will help future projects succeed.

One example of this approach in action was Pleasure Island (PI), a nighttime entertainment complex at Walt Disney World. Disney realized early in the 1980’s, as their Orlando property was growing dramatically in terms of both theme parks and resorts, that there simply wasn’t much to do in the evenings. Lots of money was leaving Disney property every night as guests drove to nearby bars and clubs to unwind. In addition, guest feedback revealed that parents on a family vacation still wanted a little bit of adult time to themselves.

Imagineering took on this challenge in a big way, developing a huge complex of nightclubs, restaurants, and shops. Using the same approach as with other huge projects, they developed an elaborate backstory for how the place came to exist. This, combined with the usual Disney attention to detail and explicit focus on creating a clean, safe, environment, made PI a unique and compelling destination.

But there were operational challenges with such an endeavor. While Disney had operated relaxing lounges in hotel lobbies, they did not have experience running clubs or dealing with the unique aspects of hiring, retaining, and leading staff in such an environment. Some management did not fully buy-in to the idea at all, thinking that nighttime entertainment might not be appropriate for Disney’s family-friendly image. For the first year it was open, PI struggled financially. It got great guest feedback from those who went, but attendance fell far below projections.

At that point, Michael Eisner (the CEO at the time) doubled down on PI. Rather than declaring failure and quietly shutting the place down, most of the management team was replaced with executives recruited from industry-relevant, successful ventures from outside Disney. Imagineering crisped up the backstory, some of the clubs were re-themed, and an intense marketing effort kicked off to attract more Disney resort guests, vacationers staying off Disney property, and locals.

With these tweaks, PI thrived. Attendance grew substantially, guest ratings remained high, and revenues now exceeded expectations. The experienced management team continued to tweak aspects of the operation but also knew when to leave well enough alone. An example of that was Mannequins Dance Palace, the flagship dance club at PI, which was Imagineered so far ahead of the competition that ten years after opening, with virtually no investment in modernization, it won Bar & Nightclub Magazine's first annual award for Best Nightclub in the USA.

Another example of a successful failure is Disney Cruise Line (DCL). Disney set out to reimagine the family cruise experience, eliminating many of the frustrations and challenges of traditional cruising while still offering all the advantages a cruise vacation offers. Here again, Disney's inexperience with a new business area enabled them to start with a clean sheet of paper but also led them to suffer some frustrations due to not having the in-house expertise to smoothly run a new endeavor of this scale. The maiden voyage of the Disney Magic was delayed twice (at great financial and public relations expense), at least in part due to the perfectionism of Imagineers who clashed with the "just get it built" mindset in the shipyard.

In less than a year, though, DCL started winning prestigious awards against some of their much more established (and expensive) competitors. Today, DCL is hugely respected in the industry, with other cruise lines scurrying to copy some of the elements that guests love. It's been said that other cruise companies provide entertainment for their passengers, while Disney is an entertainment company that offers cruises. The successful failure is clearly paying off—DCL now sails four award-winning ships, full of high-fare-paying guests all year long, with three more ships under construction.

By this point, I'm sure you're wondering what all this has to do with SSA.

## 5. CURRENT STATE OF SSA

While I had 20 years of experience in the mission area, I'll admit that over the three years I was an Imagineer, I didn't keep close tabs on how things were going in the world of space control. Please forgive me if my examples are slightly out of date, but I have a sneaking suspicion that things haven't changed all that drastically. Let's see if I come pretty close to the mark.

The United States actually does a pretty decent job of maintaining a catalog of objects in space, tracking them with some regularity, and sharing that catalog with relevant military agencies, commercial entities, and foreign partners. But when it comes to characterizing objects, predicting their intent, and protecting vital assets in space our capabilities are still pretty rudimentary. Successful programs such as Space-Based Space Surveillance (SBSS) and the Geosynchronous Space Situational Awareness Program (GSSAP) have helped in this regard, but we still have woefully little information and poor revisit times on objects of interest.

Things on the ground probably aren't much better. The Joint Space Operations Center (JSpOC) is getting additional capability through the JSpOC Mission System (JMS) program, but progress is slow. New data sources, new algorithms, and new analysis techniques are difficult to ingest due to the complexity of the system and onerous information assurance rules.

In this regard, the "A" in SSA is true only in the most limited sense. Radars, optical systems, and classified capabilities feeding two-line element sets into a catalog is not the objective. Would you drive your car with your eyes closed 90% of the time? Of course not—situational awareness when driving involves constant input and processing from multiple senses, enabling you to *anticipate* what other drivers and obstacles are going to do, to *prepare* yourself to react (or sometimes act preemptively), and to *assess* the effect of your behavior on the situation. It all happens constantly, instantly, and in the presence of distractions like the radio, conversations with others in the car, flashes of sunlight that temporarily blind you, etc.

I suspect there are at least a few major programs of record in various stages of development to provide enhanced capability for ground- and space-based data collection, each of which is suffering some degree of technical challenges, cost overruns, and schedule slips. Existing data and information cannot effectively be fused both because of how complex that is to do and due to bureaucratic infighting and security barriers.

In short, when something happens in space, we have decent capabilities to go back and forensically figure it out. But when it comes to truly understanding what's in space, and predicting events before they occur, we struggle. Is my take on where we stand still pretty accurate? Maybe there are some things we can learn from Disney about how to do a better job.

## 6. THE POTENTIAL TO IMAGINEER A NEW FUTURE

To be clear, the point of my paper is not to say that Disney is a magical company that does everything right, and in the government we mess everything up. Disney is a company made of individuals, and whenever people are involved things will inherently not be perfect. At times, I saw bureaucratic squabbling, senior leaders who let their egos get in the way of what was right, an unwillingness to make decisions, and a short-sighted focus on cost control above all else, each of which harmed projects or the company as a whole. But the *process* of Imagineering, the way Disney faces challenges and develops programmatic solutions to them, does offer some valuable food for thought.

I'd also like to point out that, while it might not seem obvious at first glance, there are many similarities between typical Disney projects and typical U.S. government space projects. The budgets are similar (tens of millions of dollars for small efforts or tech demos, hundreds of millions of dollars for significant efforts, and single digit billions of dollars for major projects), the team sizes are similar, the timelines from conception to delivery are similar, the degree of technical complexity and number of interdependent technical disciplines (requiring a systems engineering mindset to achieve success) are similar, and the paramount importance of mission assurance (whether making sure no one ever gets hurt on an attraction or a satellite functions for years with no chance of maintenance) is similar.

I had the good fortune of working on Disney projects that started as an unspoiled "green field" (Shanghai Disneyland) as well as those landlocked in the middle of an operating theme park (Matterhorn and Peter Pan's Flight "new magic" projects at Disneyland). When dreaming up new ideas to improve SSA, I realize it is more like the latter, as there are additional constraints in terms of not disturbing current operations. Still, there are valuable nuggets we could glean from looking at SSA as a "green field", imagining what solutions we'd like to put into place if unconstrained by current architectures.

What do you think a carefully-selected team of professionals could come up with if given a Blue Sky charter to reimagine the future of SSA? If all security clearance constraints, self-serving bureaucratic interests, ego-driven love for specific solutions, and regard for budgetary winners and losers were set aside? It wouldn't be totally unconstrained thinking; as I said before, even Disney's Blue Sky projects operate within a set of given parameters. Yet couldn't such a team likely envision an achievable future with capabilities far closer to the ideal than what we have today?

But I'm getting ahead of myself. I'd like to share a few personal stories from projects I led while an Imagineer, that I think illustrate a few key principles that are directly applicable to our challenges in the SSA mission area.

## 7. LESSONS LEARNED FROM MY DISNEY PROJECTS

During my time as an Imagineer, my efforts pretty much fell into four scopes of work. In each one I learned something different that I'd like to share (except for Star Wars: Galaxy's Edge, where most of the project details are still very tightly held, so I don't dare tell those stories for fear of ending up on the wrong side of a light saber), including how I think it could shape a better future for SSA.

The project I originally got hired to lead was a complete reimagining of Tomorrowland at Disneyland. Tomorrowland, one of the original themed lands dating back to 1955, had its last major update in 1998. Park

attendance has increased steadily and dramatically since then, and some major attractions had closed, making the main thoroughfare crowded and uncomfortable. In addition, Disney had recently purchased a major new intellectual property that was to form the basis of a significant expansion in that area of the park. First, the entrance to Tomorrowland needed to be improved, so we embarked on a fast-track project to do so.

From the end of Blue Sky to the beginning of construction, the team was given only about four months (by comparison, other projects of this scope typically spent about a year turning the concept art into executable drawings). We did it, through an innovative partnership with external architects and our general contractor, who were fully integrated into the project team early enough to affect the way things would be done (this was design-build, but done in an innovative way that made the architects and construction companies partners more than simply contractors). We also had embedded representatives from the operations team at Disneyland who brought in their attractions, food and beverage, and maintenance experience from the start to help affect design for the better.

Less than a week before demolition of existing Tomorrowland elements was to begin, Bob Iger (Disney's CEO) personally cancelled the project. He had a different vision for how that incredible new intellectual property should be integrated into Disneyland, so it no longer made sense to invest in the reimagining of Tomorrowland.

I was amazed at how quickly the tremendous momentum of the project was halted. In fact, I was given three days to close out all the contracts and assign my fellow Imagineers to other work. This is the power of a profit-driven company—there is no tolerance for wasting resources. So while it was painful (it's always hard for a project manager to see an effort he's passionate about fail to be completed), it was actually the right decision.

The lesson I learned was this: **Don't be afraid to cancel projects, and when you do, act swiftly and decisively.** We've all seen too many major programs in the SSA arena continue to get funded year after year, that everyone in the community knows should be jettisoned. These projects suck resources (financial and talent) away from other efforts, and contribute to a culture of stagnation. Decisive leadership in this mission area, including the power to eliminate underperforming or no-longer-relevant projects, would be welcome.

Next, I had the good fortune to take over stateside leadership of the massive Shanghai Disneyland project. While much of the team had deployed on-site to Shanghai to oversee construction of the park, there was still a lot of work going on in the United States. This included both Imagineering work (ride engineering, building specialties such as graphics and art glass, special effects design, etc.) and contracted work with companies around the U.S. who were delivering elements to China. All of that diverse work needed a leader to focus efforts and ensure products made it to the construction site when they were needed.

As part of the senior leadership team of the project overall, I gained fascinating insights into how the public-private partnership with China was structured. Only 43% of the Shanghai Disney Resort is actually owned by Disney; the majority stake is owned by three companies that are jointly held by the Chinese government. While this structure was necessary to secure approval for the project and to share the financial investment and risk, it proved cumbersome and inefficient in practice. Decision-making was often painfully slow, particularly when it came to approving cost overruns. The general contractors working on the project were also state-owned entities, with their own financial and political motives and connections. Finally, even within Disney there were competing interests between Imagineering, the ops team that would eventually run the park, the food and merchandise teams that were standing up, and various top-level executives (up to and including the CEO) who each had their own take on how the project should be run.

In the end, from a creative and guest experience standpoint, the project was a rousing success. Shanghai Disneyland has set a new standard for immersive themed entertainment around the world, and earned a Thea Award (the Themed Entertainment Association's version of the Grammy or Academy award) for outstanding achievement. Financially, the picture is murkier. The project fell well behind schedule and went significantly over budget, and only Disney's accountants know what that has done to pro forma projections as to when the park will be profitable.

While there are many explanations for the project's challenges, one that stuck with me is: **The more complicated the governance, the harder the project.** Who is in charge of the space control mission area or SSA in particular for the United States? What single leader has the responsibility, accountability, and authority to direct all efforts in support of common goals? The current "org chart" has solid and dashed lines all over the place, including Air Force

Space Command, United States Strategic Command, the National Aeronautics and Space Administration, the National Reconnaissance Office, various Pentagon staffs, the National Security Council, and of course supporting commercial entities. We need someone who can take charge to direct these various organizations, and who has both personnel and ultimate financial authority to get things done.

As the U.S.-based work in support of Shanghai Disneyland wrapped up, I was next put in charge of projects for Disneyland's 60<sup>th</sup> anniversary. Disney makes a big deal about milestone celebrations, and this "diamond anniversary" was a big one. Unfortunately, leadership looked at several projects in the pipeline that were supposed to span a couple of years' worth of effort and decided they all had to be done in time for the kick-off of the anniversary celebration. I guess it was becoming a pattern, but we again had to rally to accomplish, in a much shorter span of time than usual, amazing things.

The biggest efforts involved adding "new magic" to the Haunted Mansion, Matterhorn Bobsleds, and Peter Pan's Flight. "New magic" is Disney parlance for adding new elements to existing attractions, keeping them fresh for guests and often integrating new technology that enables better storytelling. Each project was fairly small in the grand scheme of things, but all three projects involved the same core team.

To a certain extent, a small project (particularly a fast-track project) requires just as much individual time and effort as a huge project. And when the team is small, everyone must contribute full effort, constantly, lest the project fall behind due to a single laggard.

The three attractions we worked on are each legendary in Disneyland lore. They are all classic attractions, with legions of fans who were ready to pounce if they felt the attractions were not being given the respect and attention they deserved. Particularly in today's environment of instant communication, Disney fan sites and blogs waste no time in spreading critical opinions. In addition, most Imagineers are themselves Disney fans, so we held ourselves to an incredibly high standard when touching these important experiences. Detail is always important; in this case every single detail needed to be *perfect*.

I learned several things over the course of these 60<sup>th</sup> anniversary projects that can help us improve SSA. First, **small, focused teams can accomplish the impossible, but can also be overworked**. My core team of art directors, paint specialists, special effects technicians, sound engineers, lighting designers, ride engineers, estimators, schedulers, and coordinators put in some really long hours for several months without a break. We made it a point to emphasize safety, and put up members of the team in nearby hotels many times rather than have them drive home while exhausted. We also catered in a lot of food, and made sure to take time for morale-building events even during the high-pressure push to get the projects completed. Still, stress levels were high and I know that by the end of the run, some people were near burnout. My favorite projects from my Air Force days followed a similar pattern—I am a big believer in small, focused, hand-picked teams who are unleashed from bureaucratic red tape to accomplish important missions. But we need to keep in mind the sacrifices these groups make, and not push them past the breaking point.

The smallest of these projects was adding the Hatbox Ghost to the Haunted Mansion. Right from the start, in 1969, the Haunted Mansion was a hugely popular attraction. Full of simple but startlingly-impressive effects, the Haunted Mansion has given millions of guests a glimpse into the world of 999 happy haunts. One of them was the Hatbox Ghost, but within a couple weeks of the attraction opening he was quickly removed when it became apparent that his effect was not working convincingly. This character's head was intended to disappear intermittently then reappear in a large hat box held by the character's hand, and back again, but the technology simply wasn't available to create a compelling effect. It wasn't until 2015 that Imagineering figured out a way to bring him back in a way that was convincing and reliable. Receiving almost universal praise, this project was a highlight of my career at Disney. And it taught me that **sometimes the most magic comes from the smallest projects**. Not every element of the SSA architecture needs to be an ACAT-I program. We also need to be open to the major impact that small efforts can have. For example, perhaps more focus should be put on advanced ground algorithms that leverage existing data in new ways, or more effort placed on integrating small sensors onto lots of satellites (which Space-Based Space Situational Awareness (SASSA) was designed to enable) rather than focusing so much on major, dedicated platforms.

The next project to open was the Matterhorn Bobsleds. The major elements here were the addition of new, advanced audio-animatronic abominable snowmen, a new soundtrack, the replacement of a set of mountain climber's props with artifacts collected by the snowman over time (including several nods to storied pieces of Disneyland's history), and a new storytelling element during the roller coaster's lift hill that added simulated walls of ice on both sides of the tracks where guests could catch a glimpse of an angered snowman following them up into the mountain.

Those ice walls proved to be quite difficult. They needed to convincingly look like actual ice, be as light as possible for the mountain's structure to support them, be durable enough to survive in place for decades (in a humid environment and under the constant glare of ultraviolet black lights) without tarnishing, be transparent enough to let guests see the snowman (but not so clear as to reveal the way the gag is accomplished), and finally be affordable to produce and install. We went through several mock-ups in a warehouse in Glendale, CA, where the special effects designer was able to show the creative director various solutions he had devised. Each time the director offered "notes", or suggestions on how to improve the effect. The mock-ups were not inexpensive, but proved invaluable in letting us **try, fail, and iterate quickly** to an eventual solution. When the final version was produced and installed in the actual attraction, it performed exactly as the director wanted.

Within the world of U.S. government SSA programs, we need a method by which new technologies and techniques can be allowed to try, fail, and iterate quickly. The JMS Advanced Research, Collaboration, and Development Environment (ARCADE) is a fantastic example of what I'm talking about. There, researchers and developers can play with new algorithms, using real data and tweaking their work without touching any current operational architectures. Other major programs of record should also have similar ways to try things out, tweak, and try again without jumping too early in a program's lifecycle to a potentially non-optimal solution.

Another aspect of the Matterhorn project (that actually proceeded quite smoothly) was the installation of the new audio-animatronic snowmen. Their development proceeded well in terms of cost, schedule, and performance, and I was pleased with how convincingly scary they turned out! But just a few days before we were to start installing them, a safety engineer who was only peripherally involved with the project raised a concern that (if you'll pardon the expression) stopped us in our tracks. This engineer had done an analysis that showed there was a risk of catastrophic failure that could derail a roller coaster train! Of course we rushed to his work area so he could show us this critical flaw he had found, but not before he had shared his concerns with his management and the corporate safety team. Safety is, without question, the top priority of every project at Disney. It is the first and most important of the "four keys to customer service", it is the first item covered at every project review, it is the first topic discussed at every daily muster meeting in the field... in short, safety is paramount. This engineer's pronouncement raised immediate attention at very high levels.

What we found out was that he had performed a worst-case analysis, which in and of itself is a useful tool. But in this case the cascading series of failures that would have had to occur was a statistical and physical impossibility. And these were failures not just of mechanisms but of redundant safety systems, involved both hardware and software, and included analysis of the geometry with such large error bars as to be completely unrealistic. He felt that, at maximum acceleration as the snowmen lunged towards the approaching roller coaster cars, if all of the connecting mechanisms and embedded safety interlocks failed at once, the head could potentially detach, launch itself over a large gap to bounce on the faux-snow-covered walls separating the snowmen from the track, and land on the track in such a way as to break the multiple wheels and redundant safety structures holding the trains to the track. His convoluted logic wasn't supported by the math. It was the equivalent of one of my old satellite programs where we liked to joke that the only event that wasn't on the prime contractor's risk list was that of a meteor striking their factory.

The engineer's recommendation was a redesign of several key components of the snowmen; the impact would not have been so much the cost (although that was significant) but the schedule delay. It would have taken several months, at best, to complete the redesign, fabricate new parts, and re-accomplish testing. Had the safety issue been real, we would have regrettably but understandably accepted that hit. But it wasn't! We couldn't allow a non-issue to force all of that to happen, so I worked my way up the chain of command. The engineer's boss and our embedded safety professionals, who agreed with my assessment of the unrealistic analysis, got on a conference call with me, the original engineer, and the VP of safety (who had the ultimate call to make). That VP listened to the original

analysis, then heard my objections. He asked each of the other managers in the meeting for their assessment, and at the end of the call agreed that we did not have an issue. The installation of the snowmen continued on schedule.

From that, I learned that **you have to be willing to challenge the bureaucracy**. The safety engineer wasn't a bad guy, but he was overzealous in his pursuit of unrealistically-safe systems. He also held the power to stop my project, had I been unwilling to seek a higher opinion. I was reminded of my days briefing Overarching Integrated Product Teams (O IPTs) and Milestone (MS) review boards in the Pentagon, where at least a dozen individuals had to agree with a project for it to continue but any single one of them could object and stop it right there. And in that case, no one executive leader had the power (or perhaps the will) to overrule them. Some of these individuals represented organizations with little to no relevance to the program at hand; others played politics rather than considering military necessity or merit. This represented the worst of a bureaucracy run amok, and if we're going to stay ahead of our adversaries in rapidly-evolving mission areas like SSA, we need to squash it. Regarding the Matterhorn, guests love those new snowmen, and I sleep easy every night knowing the crazy risk of a decapitated snowman causing a derailment is never going to happen.

The last major element that was part of getting ready for Disneyland's 60<sup>th</sup> anniversary was the Peter Pan's Flight new magic project. Anyone who's ever ridden the Peter Pan attraction at a Disney park remembers it—in fact, many people say their first magical memory of a Disney park experience was soaring into the air on their own pixie-dust-sprinkled flying ship, gliding from Wendy's bedroom over the streets of London and on to Neverland. It was an opening-day attraction in Anaheim, meaning it was one of the few that is still there today that Walt Disney himself oversaw. It doesn't get much more classic than that.

That being said, the ride had last been refreshed in 1983 and was due for some major TLC. This offered the opportunity to enhance the way the story was told with newer technology, including new audio-animatronics, LED lighting, and laser effects. But we were also extremely sensitive to how popular and well-loved the attraction was, and didn't want to have technology take center stage over the charming, existing story so many people enjoyed.

We broke down most of the show scenes, some to the bare studs in the walls, so that we could rebuild them to suit the new elements. Like in any construction project of such magnitude, when you do that you find unexpected surprises that never help things move quickly. In addition, this complex project involved an intricate scheduling of all the various disciplines who needed to perform their work. Many of them had to work alone, for instance during ride vehicle testing when no one is allowed to be in the ride path for safety reasons, or when the sound mixers were upgrading the audio and needed absolute silence in the entire attraction. Parallelizing work to accelerate schedule was simply not an option. We were also landlocked within the park, meaning we couldn't shuttle materials back and forth except during the precious overnight hours when no guests were present to have their magic spoiled by seeing such mundane activities.

As I mentioned earlier when talking about the Hatbox Ghost, this was largely the same team that had performed the other projects as well, and they were running on fumes after racing for several months to get all these projects open on time. Special effects were being designed on the fly, materials ordered and assemblies created "just in time" in the field. That became the long pole in the project, and everyone else essentially had to work around the special effects crew.

But when an item was delivered late (or wrong, and had to be reworked), it threw the whole schedule into disarray. People had to be very nimble, ready to get into the attraction at a moment's notice for an unexpected hour or two of work. We added more special effects resources to complete the work more quickly, to include the director of special effects rolling up his sleeves and working side-by-side with his staff at all hours of the day and night.

This was not a very efficient way to run the project, but even in hindsight I don't see how we could have made it any better. It would have been nice to have had the luxury of a dedicated special effects team, who had not been spending all their time in the months leading up to this working on the other 60<sup>th</sup> anniversary attractions—then they could have properly planned and scheduled their work. But we didn't, and that shared team had been running on a treadmill at full speed for a very long time. With every footfall I could tell they were close to falling off completely, and we in fact did have two technicians who left the project along the way, unable to continue working at such a demanding pace.

In addition to the constant stream of work and minor difficulties along the way, we were dealt a couple of heavy blows, one of which was an unanticipated request by Disneyland's safety professionals for outside "help" from the California Division of Occupational Safety and Health (DOSH). This took the schedule literally outside of our control and forced a month-long delay. Given how close to the attraction's opening date this happened, it was impossible for us to meet the target. My vice president of project management simply did not accept the reality of the situation, continuing to demand that we open on time. He gave a fire and brimstone speech to the project team about how important meeting our commitment date was (never mind that he had unilaterally pulled the commitment date almost two months to the left, without consulting with me or my team).

The speech was both pointless and ineffective—the situation was truly out of our control. Despite it all, we still beat the original commitment date (although not the accelerated one), but the damage to my team's morale had been done. When the VP gave that speech, berating us for not accelerating something we truly could not control, I learned that **aggressive targets are great; impossible ones, not so much.**

Setting high but achievable goals is a key tenet of achieving excellence. And I am a firm believer that giving a team just a little bit less (be that budget, schedule, or even personnel) than they think they need is a great way to encourage innovative thinking and achieve more than originally thought possible. But when a team's objective is ridiculous, it fails to serve as a motivator and in fact has the opposite effect. When we architect and build the next set of SSA capabilities, we should not necessarily shower the acquiring organizations with lavish resources. Nor should we expect miraculous results from underfunded, undermanned efforts. Appropriate frugality will result in the best, most elegant solutions. This requires a fine balance, as organizations already exist (e.g., DARPA, ORS, SAF/RCO, DIUx) who are chartered to move quickly and accomplish great things with small-ish budgets. We need to keep pushing in this regard but without breaking the backs of the dedicated professionals who are making magic happen outside of the traditional defense acquisition system.

Speaking of dedicated professionals, that brings to me to my final lesson learned. After the Disneyland 60<sup>th</sup> Anniversary projects were turned over, I was reassigned to the Star Wars portfolio. Even now, there's not a lot I can say about that work. In addition to being in charge of conceiving the Millennium Falcon attraction, I also had the privilege of leading the team that installed a new segment into the Star Tours simulator attraction that incorporated characters and locations from Star Wars Episode VII: The Force Awakens.

If you haven't ridden Star Tours, the basic idea is that you board a tourist shuttle that visits some of the most iconic locations and characters from throughout the Star Wars universe. Along the way "something goes wrong" and so your gentle tour becomes a thrilling and exciting adventure. The ride itself is a version of a military flight simulator, with the motion of the cabin perfectly synched to the high-resolution 3D video, John Williams-scored music, and in-cabin special effects. The exact sequence of planets and locations you visit are different every time, making the experience immensely re-rideable.

The team that added this new segment was made up of some of the most veteran Imagineers in the company. In fact, most of them had been part of the team that originally installed Star Tours in 1987, and rolled out the greatly enhanced newer version in 2011. I was the only person on the team who had not worked on Star Tours before!

I quickly realized that this group knew what they were doing. They also knew each other, and performed flawlessly together. Like a sports team that is operating at peak performance, or a car that has been tuned to perfection, my main job as the project manager was to keep obstacles out of their way and let them do their jobs. One of those obstacles was interference from above that wanted to tweak the project to make it cost just a little bit less or deliver just a little bit sooner. "Couldn't Lucasfilm deliver the new media a week earlier?", they would ask, or "Do both audio technicians really need to travel for the install?"

No, what I learned was that **it's sometimes the leader's job to leave well enough alone.** This project had been well-estimated because the veteran team was so experienced and knew exactly what they were doing. Every intermediate milestone was hit on time, and the in-cabin final install went as smoothly as could be. I handled project reporting up the chain and ensured that leaders in operations and maintenance at both Disneyland and Disney's Hollywood Studios were involved every step of the way. Because our attraction was to open in the marketing frenzy leadup to the release of the movie, one of our guiding principles was secrecy, so I also had to hold the public

relations staff (who were simply drooling to market this new attraction) at bay. The project team did their jobs, and I just tried to keep everything else out of their way.

There are some aspects of our nation's SSA apparatus and some organizations that are already operating at peak performance. Leadership would do well to protect them from outside interference, but otherwise focus their attention and efforts elsewhere where their help can have a more profound and positive effect. It can be tempting to meddle by pushing an excellent program to trim their budget or staffing levels, but this is counterproductive and risks upsetting a delicate balance. Know when to leave well enough alone!

## 8. CONCLUSION

There's a catch line that may or may not be attributable to Walt Disney that says, "If we can dream it, we can do it." It's kind of an unofficial motto of Imagineering, and encourages Imagineers to do whatever it takes to create magic for the guests. Sometimes, like with the Hatbox Ghost, it takes more than 30 years to figure out how to turn a dream into reality. But the truth is that every Disney experience around the globe began as someone's dream, and a wonderfully-talented group of professionals did the hard work of building those dreams for all of us to enjoy.

The same thing is true of SSA. Once we dream up an idea of how to do a better job of tracking, characterizing, and understanding things in space, a team of dedicated professionals can figure out the right technical solutions. We can apply some of Imagineering's core principles to help—things like starting with Blue Sky thinking, considering design/build vs. design/bid/build contracting approaches, and embracing successful failures. And as this group of professionals works, maybe they can be guided by a few of those lessons I picked up as an Imagineer:

- Don't be afraid to cancel projects, and when you do, act swiftly and decisively
- The more complicated the governance, the harder the project
- Small, focused teams can accomplish the impossible, but can also be overworked
- Sometimes the most magic comes from the smallest projects
- Try, fail, and iterate quickly
- You have to be willing to challenge the bureaucracy
- Aggressive targets are great; impossible ones, not so much
- It's sometimes the leader's job to leave well enough alone

Another unofficial motto at WDI is, "We believe happy people make the world a better place." This is not some meaningless marketing-speak or pithy, throw-away line. Imagineers wholeheartedly believe that they are answering a calling to inspire the rest of the world. When someone goes to a Disney park with their family and not only has a wonderful time but is touched by the magic that surrounds them, that is when Imagineering is at its best. By showing an example of a world where excellence, uncompromising quality, and attention to detail are possible; by letting people step into and experience a harmonious blending of art and science; by simply enabling people to let go of the worries of the "real world" for a while... Imagineers hope to inspire guests to dream, do, and achieve more in their lives too.

Our mission of space control and SSA is vitally important to society as well. Today's interconnected world depends on navigation and communication signals from satellites. Predicting the weather and minimizing the impact of severe weather events requires space systems. Global stability depends on early warning systems that blanket the globe with unblinking eyes, and so on. Any threat (whether natural or man-made) to those vital systems must be seen, dealt with, and hopefully deterred before it becomes a *real* threat.

I think we can and must improve in this regard. If you share that dream, we can do it together!