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Imagineering Magic

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THEME: WALT DISNEY IMAGINEERING

ON THE COVER:
Come take an inside look at Walt Disney Imagineering, where creativity and technology converge to produce the magic housed within Disney parks and resorts.

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DEPARTMENTS & COLUMNS

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Imagination has no limits

by Clara Berendsen

It was a Sunday morning in the streets of Montevideo, Uruguay, when I first experienced an act of magic. I must have been seven years old at the time—walking alongside my mother—when I saw it: a statue in the middle of a pedestrian street; quite an odd place to put a statue, I thought. I asked my mom what it was, and she just gave me a coin to throw in a little can placed in front of it. Suddenly, the statue started to move! It looked at me as it moved, my smile growing from ear to ear at the sight of something that was seemingly impossible just moments ago. A few seconds later, it stopped and resumed its immutable state.

Even though my mom would later explain to me the logic behind how the statue moved, at that precise moment, while looking at it come to life, my imagination was alive. Over the next month, I would look at the statues and wait for them to move, seeking that receptacle where a deposited coin would resurrect them from their sleep. As I grew up, that wonder at the moving statues would fade away, but something from that afternoon would always stay with me. You see, the real magic wasn't the statue moving but rather that it made (and still makes) me question myself: If a statue can move, what else is possible?

Imagination is a powerful tool. A person can't do what he or she can't imagine. Every breakthrough in knowledge came from a seemingly crazy idea brought forth by someone brave enough to imagine it. It's a resource that all engineers should tap. We are problem solvers, but how can you build a solution without imagining it first?

There is a well-known group that combines the power of imagination with cutting-edge engineering: Walt Disney Imagineers. Imagineers are responsible for thinking, planning, and building everything you see at Walt Disney parks and resorts.

This issue of *IEEE Potentials* provides an exclusive look inside Walt Disney Imagineering. In addition to exploring some of the groundbreaking technology created for Disney theme parks (including *Star Wars*: Galaxy's Edge at Disneyland and Walt Disney World), you will learn how you can chart a path toward a career as an Imagineer. It's going to be a fun ride!

As members of the IEEE, it's crucial that we keep the fire of imagination shining bright because we have an added responsibility to use our knowledge to work toward the betterment of society. I hope that you are inspired by the stories and experiences in this issue to keep on imagining. May the force be with you!

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The world of Walt Disney Imagineering

Craig Causer

There is no bigger dreamer than Walter Elias Disney. Through the melding of imagination and engineering, Walt brought to life a mouse who matured into a global goliath. Classic animated films, *Star Wars*, Marvel, and *Avatar* are just a few of the heavy-hitting intellectual properties residing under the Disney banner. When it comes to mass media and entertainment, a mouse shall rule them all.

But if Mickey is the face of the Walt Disney Company, in many ways, its parks and resorts are the heart. It's here that worlds, created through big ideas, technological acumen, and creative solutions, are experienced in three dimensions, lifting wonders off television and movie screens and into the real world for people of all ages to see, touch, and hear. The driving force behind such wizardry is Disney's Imagineers (a melding of the terms *imagination* and *engineering*), who operate in more than 140 varying disciplines across 12 theme parks, four cruise ships, and a vast array of consumer products.

Earlier this year, Walt Disney Imagineering (WDI) hosted *IEEE Potentials* for a weeklong visit to learn more about how creativity and technology come together to produce the wonder housed within Disney parks and resorts. With a tour of WDI's Glendale, California, headquarters, access to more than two dozen Imagineers, and a guided walk-through of Disneyland with a WDI site team member, this exclusive view inside a global entertainment juggernaut is evidence that innovation requires a combination of technical know-how, big ideas, teamwork, and even a little bit of magic.

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If these walls could talk

Roaming the corridors at WDI is akin to having one foot in the past and another in the future. The walls are lined with historical moments and creative tributes, including John Hench Graffiti Hallway, where various pieces of original artwork are scrolled in honor of the former designer, creative director, and Imagineering legend (as well as the official portrait artist of Mickey Mouse for 50 years), who passed way in 2004. While there is plenty of retrospection on display, the various departments at WDI are eyeing the future.

Stopping at the Model Shop reveals the core of Imagineering: drawings and scripts that have been transformed into 3D pieces. Both old- and new-school methods are implemented, including traditional model building using foam, cardboard, and wood as well as 3D printing and laser

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cutting. On display was a model of the Guardians of the Galaxy: Mission Breakout! attraction at Disney California Adventure in Anaheim, which was a radical transformation of the Tower of Terror. The model was used to understand how to paint the building, and it was shipped down to Anaheim, where the in-field art director offered it up to the painting contractor for reference. While models may appear to be beautiful pieces of art, they are just working tools, explains Jonathan Friday, creative director at WDI. At the end of a project, the models are either put into storage or, in some cases, destroyed. "The experience you get as a guest is the actual product we are making," Friday adds.

The tour continued to the Sculpture Studio, the only place at WDI where you can find Dick Van Dyke, former U.S. President Bill Clinton, and the visage of Johnny Depp keeping a watchful eye on Julie Andrews and Humphrey Bogart. The Dimensional Design Department creates the study pieces that help Imagineers build all of the *Audio-Animatronics* that appear in the parks. "We are doing a lot of 3D printing when it comes to sculpts these days, especially if we have those assets available to us from our partners at Pixar Animation Studios or Walt Disney Animation Studios," explains Friday. "*Frozen* was done in 3D, so why would we sculpt it when they can sculpt it digitally and provide that to us as a file that we can clean up and then mill out and provide to our partners here? We are doing a little bit of both these days, but all of our classic characters, including Mickey Mouse, still get done in a traditional sculpt when we are doing our first pass at them. We are really blending legacy with a lot of really exciting technology."

Not far from where Julie Andrews' head rests is where the sound of music comes together—the WDI Sound Studio. Principal Sound Mixer and Chief Engineer Greg Lhotka provided insight into the studio, which he describes as WDI's "sandbox for audio." The room contains a 3D audio system, where a piece of audio can be played in one particular spot in a room, essentially rendering audio in a physical place. This audio system is utilized at Walt Disney World in Avatar Flight of Passage at Disney's Animal Kingdom, in the stretch room in the Haunted Mansion, and as part of the new Soaring: Fantastic Flight attraction in Tokyo DisneySea. Despite the innovative in-house technology, only about 40% of the sound work is done in Glendale, Lhotka says. Most of it is performed in the field in the attractions. "We basically have a sound system in road cases," he notes. "We have 14 of these that we ship all over the world to wherever we need to go and work. We'll actually do our final mixes in the space, which is a lot of fun

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Imagineers work on a model designed to bring Arendelle from the world of *Frozen* to life.

The original Disneyland concept map, hand drawn by Herb Ryman in 1953, is housed at WDI Archives.

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Step into the DISH, a virtual reality tool that helps evaluate the designs of attractions and determine audio cues and special effects.

because you can't really mock up your typical ride in a studio. It's easier to just go there and sit in the space."

Being rooted in Glendale means that sound is not the only set of waves being created in the region. With the seismic activity that often occurs in Southern California, there is one particular location where protection is paramount—Imagineering Archives, which is dubbed by Mike Jusko as "the most secure room in all Imagineering." As the principal art archivist, Jusko oversees a collection exceeding 80,000 works of original art crafted by more than 2,000 Imagineering artists going back to 1948. He unveiled the single most important and valuable work of art in the entire Walt Disney Company: the first drawing of Disneyland, completed over the long weekend of 23 September 1953 by artist and Imagineer Herb Ryman. Ryman's work was reproduced and included as part of the pitch kit to sell people on the idea of Disneyland, since theme parks did not exist at that time.

Visualizing the future is a continuing Disney hallmark. In its Concept Lab, physical mock-ups and top-secret prototypes are created for upcoming attractions in parks and resorts across the world. To aid in developing these constantly changing creations, Imagineers utilize the Digital Immersive Showroom (DISH), WDI's preeminent environment for looking at projects in virtual reality, including rides, parades, fireworks shows, and resort rooms, among others. "We are actually projecting on all of the walls and the floors in here in 4K and in 3D stereo," explains Garrett Clark, creative technology designer. The space is often used as a tool to look at upcoming attractions. But what makes the DISH special, in addition to its projection technology, is that it possesses a motion-capture system able to track various objects within the room. What you see as you walk around the space is the updates the system is making in real time based on your position and where you are located in the DISH. "What we can do here is gather data and sign off on something before we even break ground on attractions, so once the construction has started, we know that it won't need any major changes," Clark adds.

Ride along

When an attraction moves into a concept design effort, various teams come together to begin working on how the experience is going to be delivered. One of those groups is the Ride Mechanical Engineering (RME) Department, which supports the development of new ride systems being added to all Disney theme parks. The team, consisting of approximately 40 mechanical engineers and mechanical designers, focuses on vehicle and track design/safety and follows a rigorous standard-based design approach to ensure that consistent and appropriate decisions are made. (WDI's Ride Engineering Studio, which comprises electrical engineers and software engineers, numbers around 150 Imagineers.)

RME projects follow similar steps. First, a creative lead defines an aspirational experience—what Imagineers want the guests to see, hear, feel, and do. Once a consensus is reached, it gets pitched to senior leadership for approval, and the engineers begin their involvement. For RME Imagineers, their job revolves around designing and building the machine that moves guests through the story, whether it's a vehicle, simulator, or other one-of-a-kind mechanisms.

"[There are] boat rides, roller coasters, autonomous free-ranging vehicles, you have Level 5 driverless vehicles driving around our parks in some attractions," describes Dave Crawford, executive, RME. "Engineers on my team typically aren't narrowly specialized. They are very capable and have diverse expertise. It's not my expectation that when they're cast on a new project that they are an expert in this area, but they are great at figuring it out, diving in, and learning what they need to do to be successful. Siloing someone in one component of work is not the best thing for them, usually. We want to give them broad experience. I'm trying to match skills, interests, and capabilities with the project needs at the time. It's a fun and challenging puzzle. As an engineer, I've moved from puzzles that are machines to puzzles that are more about people's development and careers and trying to put them together with project assignments in the best way for each person."

One of the more interesting development projects that Crawford worked on was the Seven Dwarfs Mine Train at Walt Disney World in Orlando, Florida, which contained a swinging seat bucket on the ride vehicle. The finished design resulted from exploring a guest compartment that could freely swing with the dynamics of a ride. While it was

immediately apparent that it was technically feasible, Crawford says, the bigger question was will it be fun?

"What we do in our development processes is go through a series of mock-ups and iterations and cycle tests to address risk," Crawford explains. "That one had creative risk—is this going to make people sick? We built a mock-up, nailed it down in the back of a truck, and drove it around a parking lot for two weeks testing it with everyone we could. We tried different speeds and turn radii and different iterations and variables and created the most exciting experience that we could. We presented it to the team that was in charge of the new Fantasyland at Walt Disney World, and they said, 'We'll take this right now.' It turned out to be a huge success."

The RME team is similar to many WDI departments in that it relies on the talents of Imagineers with varying backgrounds and levels of experience. For Courtney Kobata, two WDI internships led to her current role as associate ride mechanical engineer. Her first internship exposed her to the way Imagineers work, and the second one tossed her right into the fire of working on drawings of the now-operational Incredicoaster at Disney California Adventure. In her first year and a half as an Imagineer, Kobata experienced nearly all the different phases of a ride through design, production, and installation.

"For students, I always recommend getting involved with projects where you get to build something yourself," advises Kobata, who earned her B.S.E. degree in mechanical engineering and applied mechanics and her M.S.E. degree in robotics, both from the University of Pennsylvania. "Coming in here, I had done Formula SAE Electric, so I worked on electric race cars, and I think that helped expose me to a lot of manufacturing things, designing parts, and participating in larger skill efforts that you don't necessarily get in the classroom. A lot of colleges do a great job of preparing people theoretically. Having that hands-on knowledge and bringing that into a job is very valuable. You're not just designing something that looks good off of the computer; you've had experience making a part using specific materials. Being able to have that in the back of your head while you're working is always beneficial. Get your hands dirty, and learn how things work."

Creatively collaborative

Examining the potential of future magical experiences is the job of the WDI Creative Show Studio, which handles the front end of the creative development process, including the earliest writing, concept designs, illustrations, and ideas that inform what Imagineers are going to create. Once a concept passes creative muster, it moves to the actual design for production, spreading out to 20–30 different disciplines spanning sets; scenic show lighting; show audio design; show control; overall systems design for an attraction; media, visual, and practical effect design; character animation; animatronics; rock work; and hardscape, among others. These include all the aspects that the guests feel, listen to, and see that informs their experience.

The Seven Dwarfs Mine Train at Walt Disney World resulted from exploring the ability of a ride compartment to naturally swing with the dynamics of an attraction.

Avatar Flight of Passage was created through the input of many Imagineers who answered the question: How do we create an experience where you can fly through the world and feel like you're riding on the back of the Banshee?

Along with a unique ride vehicle, the Seven Dwarfs Mine Train features various *Audio-Animatronics* figures.

In the past, how these concepts were assembled was a bit regimented, says Christian Kubsch, Creative Show Studio executive. Originally, there was an isolated creative element that evolved into a story and then an idea for how that story would unfold. At that point, it was handed over to a team to execute that idea. WDI now touts a more collaborative process in which input from engineers and software developers is part of the early creative process, resulting in a more holistic design intent that considers more ideas of what is possible.

"When you're looking at Avatar Flight of Passage, which is an attraction that everybody is talking about, it's really informed by an idea," Kubsch clarifies. "The way that you interact with everything is sort of a reflection of the inputs by many of the engineering folks who came up with the answers to how do we actually create an experience where you can fly through the world and feel like you're riding on the back of the Banshee? What are the types of things we would need to come up with to allow someone to feel that way, and what story elements can we set up as we get there that basically sell you the reality as you experience it? That is a collaborative effort, where many people on the outside might think, 'Oh, that's a bunch of storyboard artists and a couple creative directors in a room dreaming this up.' It is really something that encompassed a whole variety of different people with very diverse backgrounds."

With decades of beloved attractions under its belt, WDI has developed confidence in knowing how long it will take to complete a project that is similar to an attraction at another Disney park or one in which Research and Development must work to come up with something that hasn't been done before. According to Kubsch, another facet that makes WDI's approach more efficient is that it relies on unique ways of innovating in the virtual space, thereby providing Imagineers with the knowledge of how an attraction will operate long before it is built. The information gathered from virtual designs and tests is then shared among teams to further enhance the development process.

Ideas mature to become living concepts only through the input and participation of numerous Imagineers spread throughout various departments. This ability to collaborate and shift focus, when required, is extended to WDI's philosophy regarding its employees.

"In this environment, being exposed to 20, 30, 40 disciplines that are surrounding the area you're working in is enlightening," Kubsch says. "The system that we've set up is loose enough that it allows you to actually make a shift and be cast in something that you may not have ever thought you would be interested in when you came into the organization. I think the younger generation would like to have options and be able to move and have quick upward mobility potential. The perception of this organization, maybe because it's been around for so long, is that it has a lot of rigor about moving careers. In the last four years that I've been here, we've been trying to break that up and change, and we're seeing enormous enthusiasm around that because it really allows people a lot of opportunity to build their careers."

Keepers of the castle

From time to time, even Sleeping Beauty Castle needs a little pixie dust to keep it fit for a princess. Approximately every 10 years, the local WDI site team at Disneyland undertakes the repainting and upgrading of the only Disney castle whose construction was overseen by Walt.

"We try to make sure that your Disney experience isn't necessarily the same one you had as a kid but that it's strikingly similar so that you feel that connection," explains Art Director Michael Dobrzycki during a walkthrough of the park. "When you come here with your kids, and you want to have them in that picture with the castle that you took when you were a kid, we want to make sure that it's recognizably that castle but maybe with a little more plussing. Every time we do a castle repaint job, we'll add things like the squirrels that are the drain pipes that come out of the castle, which were added a number of refurbishments ago. There's always going to be the same base of the castle, which is going to be the nice cool blue-grays of the rock and the warmer tones on top."

The rehab was spearheaded by Art Director Kim Irvine, who executed a new, full-color board rendering of the castle. When dealing with a canvas that is actually brick and mortar, Irvine physically mixes the colors she is considering since digital reproductions are not entirely accurate, Dobrzycki adds. Irvine then paints the various colors on flat 2-ft × 2-ft panels. Either first thing in the morning or at the end of the night, the panels are placed on the castle at a distance where Imagineers can view the range of colors and assess them.

"We use a lot of our industry tricks," Dobrzycki acknowledges. "Forced perspective is not just an architectural feature; you can also mimic the effect of natural haze over distance by desaturating your colors as you go higher. This is known as atmospheric perspective, and we use it to give the illusion that the castle is taller than it really is. Enforcing that, you want to make sure that your whole range of colors works, so we have a lot of big color panels that we come out and check pretty regularly. You're doing this during the night. A lot of the tricky subtle gradations can't happen at night, so the quieter work we can do during the day."

Work during the day is limited to not disturb the guest experience. But what to do about all of the scaffolding required to refurbish a nearly 80-ft castle? The solution was enveloping the work in a scrim adorned with a 1954 concept illustration of Sleeping Beauty Castle by Disney artist Herb Ryman. While there may be no substitute for having your picture taken in front of one of Disney's iconic castles, a scrim provides visitors with both an element of visual history and an original story to tell when looking back at their photos.

While some of the projects involve significant refurbishments like the castle or the creation of entirely new lands such as *Star Wars*: Galaxy's Edge, the Disneyland local site team is also tasked with responding to the daily operational needs of the park, which occur on a much quicker turnaround schedule than the larger endeavors. The team is approximately 50 Imagineers strong, and it addresses issues and changes with the times, all within the construct of a 64-year-old park that may have not been built or have the optimal real estate available for many modern initiatives.

"There was no such thing as mobile ordering when we first opened," Dobrzycki explains. "Of course, we want to address things like that at a number of different locations. We don't necessarily want to do it all at once because you don't want to shut down half of your food operation for an untested initiative. We do a lot of pilot programs, and if they are successful, then we go about making it a permanent and ruggedized system. I say ruggedized because most of the technical specifications we have on any items that a guest will touch need to be much more robust here at Disneyland than almost any other industry that thinks they are a comparable entity. We have vendors that will say they do this [type of work] for stadiums or a bank, but we found that the usage that we put it through is much more rigorous than anything else on the planet. We are here to make sure the Disney experience is sustained through all those kinds of changes."

(a)

(b)

(A) IS COURTESY OF WIKIMEDIA COMMONS/JENNIFER LYNN. (B) IS (C) DISNEY

Disneyland's Sleeping Beauty Castle (a) during its 60th anniversary in 2015 and (b) after its refurbishment in May 2019.

Whether it is freshening up classic attractions or building entirely new ground-breaking amusements, the Disney experience is driven by Imagineers possessing broad sets of both creative and technical skills. This *IEEE Potentials* theme issue on Walt Disney Imagineering pulls back the curtain to reveal the work behind the magic that has entertained guests for more than 60 years.

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Disney tech: Immersive storytelling through innovation

Craig Causer

One approach that cuts across all departments at Walt Disney Imagineering (WDI) is that everything starts with a story, and technology is utilized to serve those tales. The constant advancement of technology in WDI's various disciplines has opened up entire new worlds and their stories to generations of guests, old and young alike. Decades ago, one could only dream of flying the Millennium Falcon or watching astromech droids rolling through a crowd while essentially living inside a fictional universe. Here is an inside look at how some of the technologies being explored at WDI are powering new adventures at Disney parks around the globe.

Rolling with Jake

When visiting Disney parks, it's not uncommon to see scores of people marveling at the sights and sounds of dreams brought to life. But for *Star Wars* fans, witnessing an autonomous droid roaming Disneyland in Anaheim, California, is an entirely new type of magic. Jake, a weathered orange and white robot, was tested by navigating the crowds and greeting people in front of *Star Wars* Launch Bay in Tomorrowland at Disneyland. While autonomous robots were not rolling around the parks when *Star Wars*: Galaxy's Edge opened at Disneyland in May 2019, Jake's advancement is the new hope forging the future for AI and autonomous robot experiences.

WDI was involved in the AI and autonomous robot space before *Star Wars*: Galaxy's Edge was ever proposed. AI is a "pretty squishy term," explains Michael Honeck, senior R&D Imagineer. It can range anywhere from something that is the very basic definition of AI, which is simply a computer using input to make decisions. There is also the much more emerging machine-learning space of being able to feed a computer fuzzy data and have it produce a human-like decision.

What has catapulted the fields forward is the current affordability of sensors that provide robust, high-fidelity information at the scale that Imagineers require, says Honeck, "Now we are in a place where sensors are going through another evolution," he explains. "Things like lidar, for example, are beginning to be certified to international industrial standards. So we can be sure that we're getting quality data and hardware that will perform in the field. It really extends the kinds of experiences we can bring to life. Character interactions like this could once only be achieved through puppetry or telepresence. Today, robotics can

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build on this new generation of hardware that enables computers to make creative and operational decisions on their own, and to do so reliably."

At their core, robots like Jake are navigating, emoting, and interacting with guests. There is a physical structure that can move around, but there are myriad other components that execute intelligent tasks. "You've got a head that can express different emotions based on how it's tilted," Honeck says. "We went back to the basic animation principle of anticipation. If you have an animated character and you want it to look in a direction, you move the eyes, and then the head, and then the shoulders along this line of action. We do the same thing with this autonomous system. Its head moves to look to where it's going to walk, just like a human would. That both makes it seem alive and intelligent, and it also gives humans a subconscious cue about how this thing is going to behave and how you might want to adjust your behavior relative to it. A good example is how humans interact with their pets. Those relationships are going to tell you quite a bit about how humans are going to successfully communicate with an autonomous system."

Honeck performs some droid maintenance on Jake.

©DISNEY

Testing has proven that children are connecting with Jake's personality.

©DISNEY

Personality and emotion are essential to such a project, but the robots must also be robust, maintainable, and able to survive interactions with throngs of people who are treating them as living and "breathing" things. As a result, WDI leverages the knowledge across all of its disciplines. Since a droid has wheels and suspension, the ride group is consulted. The head is essentially an *Audio-Animatronics* figure, so show mechanical engineers and show animators are called upon to discuss best practices. Of course, an autonomous robot must look like an authentic character, so model shop and shell technicians provide an understanding of how to take requirements (such as sensor clearances), meet all of WDI's safety standards, and wrap that in a design language that is authentic.

While droids would be asked to weave their way through heavy crowds on nonlinear pathways, powering an autonomous robot is less of a challenge for technical reasons; it's more a matter of addressing safety and regulatory issues. Batteries with appropriately safe chemistry and long life are available, although fitting them into the limited space of a robot can be a bit of a challenge, Honeck admits. In his day-to-day experiences, Honeck says the team spends as much time on regulatory challenges as they do on the technical and creative aspects of robot building. Imagineers are out on the bleeding edge of what is available as far as sensors, batteries, and components go, and many of the companies that produce such evolved technologies just haven't walked down the regulatory pathways that WDI requires.

"These are very much early days," Honeck explains. "We're thrilled that our guests connected so strongly with Jake. But when we look at the sophistication of other robotic systems we have in development and how Jake fits into our extended creative vision, he's kind of like an amoeba. He's the very beginning of what's going to be possible here. The learning really begins once these experiences enter daily operation. Over the long term, what do guests expect of this thing? What are the ways that we can push to meet and exceed those expectations? Once you're in that operational reality, the people who are experts in operating, maintaining, and sustaining are in the driver's seat. And with their help, the technology goes places that we never even thought to consider originally because we're so focused on getting that initial vision realized, out the door, and into operation."

©DISNEY

The hardware ecosystem built into *Star Wars:* Galaxy's Edge utilizes various technologies, including innovative use of Bluetooth, that allow the land to sense different activities and events that guests have experienced throughout it.

A living land not so far, far away

Piloting the iconic Millennium Falcon has guests in a frenzy at Disney's new *Star Wars*: Galaxy's Edge in Disneyland and Walt Disney World in Orlando, Florida. (The land's second attraction, *Star Wars*: Rise of the Resistance, is scheduled to open on 5 December 2019 in Walt Disney World and 17 January 2020 in Disneyland.) But the lynchpin tying it all together is Black Spire Outpost, the locale in which the *Star Wars* amusements reside. Black Spire Outpost is much more than rock and steel and rebels and rogues—the land itself is alive.

"We are treating the land as the third attraction of *Star Wars*: Galaxy's Edge," says Casey Ging, senior concept designer. "From the beginning, we've said there are going to be things that are familiar to you and things that are not so familiar, and you should be able to organically discover what those things that are not so familiar to you actually are. Every piece of content in this land, every droid and every mark on a wall, has a story behind it. Why is that droid broken? Where did those blast marks on the wall come from? Who are the characters that own these shops? What are their relationships to one another? All that stuff is discoverable organically through this experience, and it's something that hasn't been traditionally available through themed entertainment."

With the introduction of the Play Disney Parks app, Disney is looking to take that type of content, customize it, and deliver stories through guests' smartphones. The app started with queue-based games and music integration throughout the parks. But Galaxy's Edge goes beyond the queue to allow guests to build a reputation and let their story unfold throughout the land, if they choose to opt in. For example, in *Millennium Falcon*: Smugglers Run, your participation and interaction within the attraction not only impacts the story as you play through it but also the other stories that you will experience throughout the land. If you do really well piloting the Falcon and depart with a lot of fanfare, credits, and success, that result will follow you throughout the land. If you perform poorly and, say, make your way over to the Cantina, people may have some choice words for you for banging up the ship.

Creating this new "living land" from the ground up allowed Imagineers to create a hardware ecosystem throughout the area, utilizing various technologies, including innovative use of Bluetooth, that essentially allow the land to be a platform to sense different activities that you have done throughout it. "One of the challenges of creating these systems of technology that talk and communicate with each other is creating a team," states Producer Rachel Sherbill. "It took a huge number of people with incredible expertise in everything from networking solutions to electrical engineering to scheduling to building construction, because all of these things need to be maintainable for all of the years that this land will be around. It requires input from architects, technology designers, engineers, and software developers, who have been a huge part of figuring this thing out. These people and the systems that they are creating all need to talk to each other and have a seamlessness to them."

Since the content is driven through individuals' smartphones rather than

singular installations throughout the outpost, the land can have multiple people experiencing the same thing at the same time or enjoying different things at the same time in different ways. Leveraging smartphones helps with bearing the load of the thousands of people that will explore Galaxy's Edge. The project included the platform team and software developers to ensure that the different systems put in place understand the correct load so everyone who wants to participate in the interaction can do so.

Through the Play Disney Parks app, guests can interact with Black Spire Outpost activities such as hacking, scanning, tuning into transmissions, and participating in missions.

"Traditionally, we build these attractions to last a very long time," Ging adds. "The difference here is that we are building a platform that needs to be flexible to match the velocity of technology. Technology changes, particularly on cell phones, a lot faster than it ever has. So, a big challenge is building something that is flexible enough to still be relevant—not just six months but 5–10 years down the line when technology is almost unpredictable at that stage. We work with some of the best technologists around, just listening to their vision and understanding their view of the future and how technology is going to change over time. That impacts the way that we think about these experiences."

For the first time since the original film was released in theaters in 1977, fans now have the opportunity to live their own *Star Wars* adventure as they explore the Black Spire Outpost. The web of living land technology ties together an ecosystem designed to

The land came alive for some heavy-hitters during the 29 May dedication ceremony for *Star Wars:* Galaxy's Edge (from left): Chewbacca (in the Millennium Falcon cockpit), George Lucas, Billy Dee Williams, Mark Hamill, Disney Chief Executive Officer Robert Iger, and Harrison Ford.

allow guests to more deeply dive into the story details of the *Star Wars* universe.

There is an unprecedented number of things with which to interact, including activities such as hacking, scanning, and tuning into transmissions. There is also a series of missions available for guests who want to completely dig into their own personalized narrative and get involved with deeper storytelling. There are items that people can collect digitally—seeing the land, looking through it, and discovering items. For example, Ging explains, there are many crates located all through the area. Guests can scan them, discover what's inside, learn where they are supposed to go, and collect some of the digital items. Each task furthers the in-land story.

On this living, breathing, real-life planet, all of the droids, items, and characters found by guests are also real, including the ones you get to build yourself. At the Droid Depot, visitors can assemble customized companions who utilize technology to react with the land around them as if they are truly living droids.

"You're not just experiencing *Star Wars* on an attraction, you are experiencing it walking down the street and discovering what's in that crate or looking at a drawing or a sketch on a wall," says Sherbill. "Through leveraging technology, you can actually go up to a droid and, using your phone, receive content that helps you understand that droid's history. Maybe it has important information that it needs to get to the Resistance. All of these sorts of details expand as you are walking around throughout your day. One of the things about this type of content existing digitally is that we can update, change things, and add more stories. It's a key way to keep things fresh, flexible, and timeless."

We are Vyloo

There is no better example of how WDI projects can grow than the Vyloo, cute and fuzzy birdlike creatures who were developed with the goal of building compelling interactions with simple animatronic characters. What began with this targeted idea ultimately led to a home in the Disneyland attraction Guardians of the Galaxy–Mission: Breakout! and a brief cameo in Marvel Studios' *Guardians of the Galaxy Vol. 2*.

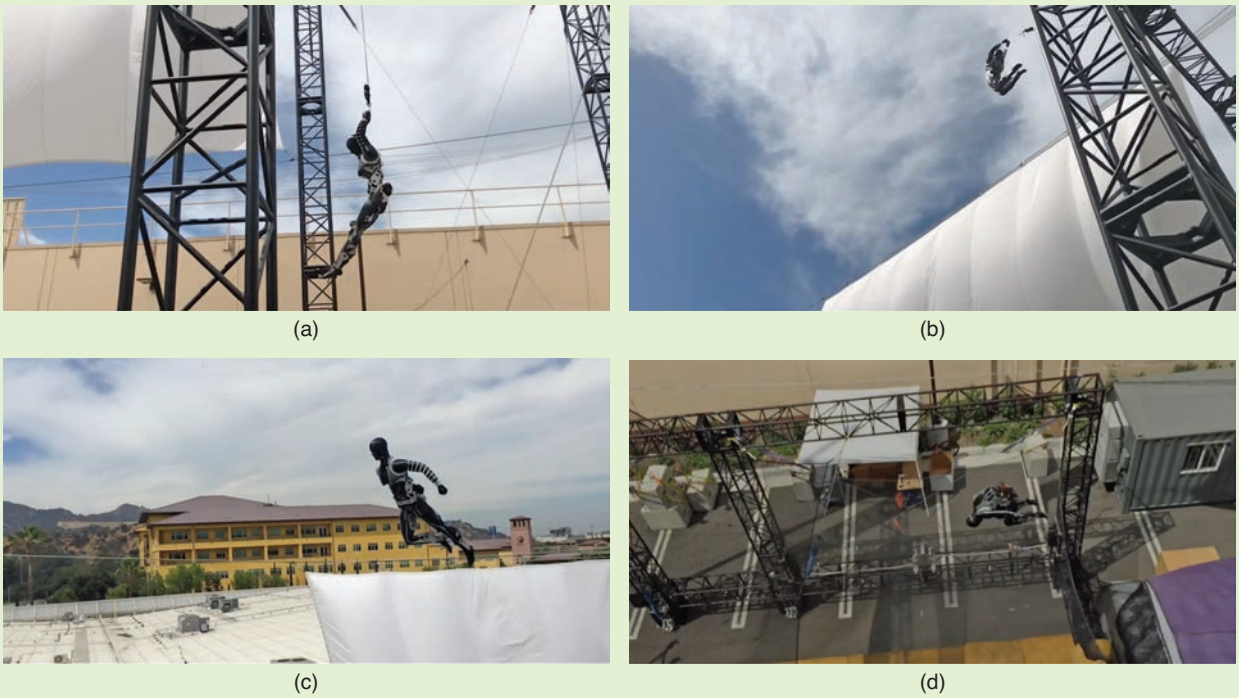
The inspiration for the Vyloo initiated with a look back at the history of Walt Disney animated features. One of the hallmarks of Disney films is the variety of woodland creatures that interact with human characters; they are smart and charming but don't have the luxury of human speech to convey their thoughts and feelings. Consequently, the dream of filling Disney parks with engaging, interactive, autonomous simple creatures was born.

"Essentially, we had to start out by making a choice: Are we going to build a familiar Disney character, or are we going to build a unique creation?" recounts Leslie Evans, R&D Imagineer manager. "In this case, we decided to build a unique creation because we wanted to explore how we can approach our animatronic characters as actors. We want to be able to teach each of our animatronic characters a unique personality—you're shy, and you're outgoing, and you're really sleepy—and then let them use their programmed thinking patterns to interact with the world. Because we knew we wanted to explore a breadth of personalities, we recognized it was more important to be flexible than to represent a specific character. So we decided to invent our own unique creations."

Development of the Vyloo started with puppets. Evans, who worked on the project with Executive R&D Imagineer Alexis Wieland, created a simple rod puppet from spare parts and materials from other WDI projects and used it to explore personality types. How would an introvert say hello to someone? If you are shy and see a new face, how do you move? Imagineers filmed and recorded these experimental sessions and analyzed what each motion meant and how they could distill those motions down into something simple, yet autonomous.

The result was a creature with no human in the loop. The Vyloo were programmed, told their personalities, and left to run all day, every day, making their own choices. There is no behind-the-scenes puppeteering; it's AI, and the characters go about each day doing their own thing. There is some universal design in the Vyloo. Evans learned which motions were

The Vyloo were programmed, given their personalities, and left to run all day, making their own choices while interacting with the people who move through the Guardians of the Galaxy–Mission Breakout! queue.



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(a)–(d) The current iteration of the Stuntronics robot experiences 15-G acceleration and lands into a net at approximately 12 Gs.

really compelling and helped convey the emotion of the character. Vyloo have eight functions, and through playing with them, she realized that body squash and stretch were important. However, any universality should not encroach on the uniqueness of each character.

"They are all a little bit different, and each has its own agenda," Evans explains. "We believe passionately that play-testing is important. You build a thing, but you have to get people in front of it to really understand how people perceive it, and then you can make tweaks based on that. We had done some early testing at Imagineering, but when we installed the Vyloo in the park and shared them with guests, we learned some new things. What was important in our technology was retaining flexibility in the system, so as we learned, we could quickly make changes. When we first turned them all on, it was like they were real animals—they were very overstimulated. So we had to dial things down. We made those changes, got them back running again, and watched how guests interacted with them."

The design of the Vyloo culminated in a demonstration of the three original characters to introduce them to people across the Walt Disney Company. The visibility led to a connection with the team working on the Guardians of the Galaxy–Mission: Breakout! attraction, and they thought it would be an interesting addition to the ride's queue, which is a display of the menagerie of Taneleer Tivan, the Collector. From there, they caught the attention of Director James Gunn and the crew working on *Guardians of the Galaxy Vol. 2.* resulting in a brief cameo in the film. "It was an exciting way for various business units within the Disney Company to work together to tell the story and bring these creatures to life across a couple of different mediums," Evans says.

Working in an advanced development group, Evans notes, often results in physical projects and ideas that do not leave the building in the form in which they were realized. Pieces of technology may move to other projects, or the experience will inspire other teams to incorporate it into their work. But the diversity of tasks—including app-based experiences, drones, character experiences, and robotics—allows Imagineers to tackle these new problems that all have a backbone of trying to use new technology to bring experiences to life.

"I sometimes wish I had known earlier in my schooling just how important technology and software would be to so many things that we tend to take for granted," she admits. "People are using game engines now to prototype things that we couldn't have imagined a decade ago. The applications for technology in the entertainment industry are only growing, and I think it's a super-exciting space, especially for people who want to live halfway between the engineering and design worlds."

Airborne bots

When Tony Stark rockets across the Marvel Universe, the visual wonder is a result of computer-generated graphics.

The vast collection of Disney intellectual property is ripe with characters that take to the sky, but current theme park animatronics tend to be rooted to the ground. Stuntronics—a combination of the terms *stunt double* and *animatronics*—aims to uproot the status quo and launch robotics into the heavens. WDI is working to bring to life a realistic robotic figure with the ability to execute complex, acrobatic stunts. Imagineers designed a 90-lb Stuntronics figure that makes its own real-time decisions, such as when to tuck its knees or maneuver its arms, while flying through the air.

The project began with the BRICK (Binary Robotic Inertially Controlled bricK), says Tony Dohi, principal R&D Imagineer. WDI Associate Research Scientist Morgan Pope started off with a rectangular robot that weighed approximately 5 lb, and it included weights, an inertial measurement unit (IMU) on board, a laser distance finder, and a simple microprocessor. Pope took it up to a high ceiling, spun it on a threaded rod, and let it go. The BRICK whirled at various rates, dropped, and shot its weights out at the right time so that they passed through an opening that was approximately 3/4 in larger than the actual size of the robot. This early test would lead to a much more humanlike evolution.

"We started off with something quite simple, and it was a robot that you could barely even call a robot—it had no motors or CPU on board or sensors, but it was tough and durable and it wasn't tethered," explains Dohi. "We used the infrastructure around it to have all the smarts and the robotic controls and the show control system. We launched this entirely passive figure across the room, and it landed 13 ft down on a long table. It would be picked up by a magnetic base, and it would skid. Because it was a very cleverly designed automaton, if you will, with dampened springs in it and latches, it would come up and do a very simple animation. We soon realized that we could spend all of this design work trying to come up with this very clever but passive thing, or we could switch gears and start to actually put the smarts back into the robot, keeping it untethered and making it as autonomous as possible."

The next stage evolved into the Z-shaped "Stickman," which was a body with three sections and two flexible joints and also utilized an IMU and laser distance finders so that calculations could be conducted on board the robot. The goal was to move beyond just a timing-based series of moves to actually control the variables that you get from a robot (for example, swinging from a pendulum, having it release, and then executing an action). Imagineers wanted it to land in a very specific orientation but have control of the performance as to when it would tuck and untuck to change its rotational velocity.

"There's a timed sequence of events, and then we'll let the IMU feed it data based on its spin rate and its height," Dohi indicates. "Because we can always know where it's going to land, it's just doing projectile parabolic motion. Knowing those things and the parameters we have to work with, we let the IMU interrupt when we know it needs to have a final position in a certain orientation. We now have an understanding of the behavior of how this thing needs to move through the air because we've studied acrobats. We have one on our team who gives us his intuition about when you need to move. If we assume a robot that is more anthropomorphic, we are looking at moving things asymmetrically at the right time and inducing a twist depending on the configuration and which axis is the most stable as this thing goes through the air."

Knowing the center of mass for every part of the entire system is essential to the robot's execution upon launch, Dohi adds. Therefore, the robot is disassembled, the arms and legs are weighed, it's put together as a system, and the center of gravity is determined. Imagineers also perform simulation work to see how it should perform and get a rough guideline of when the timing cues will occur. They then see if the robot is matching the simulation; the more precise the measurements on the robot pieces, the more accurate the simulation. "We've had really close correlation between the two," Dohi says, "which is nice because sometimes simulations don't get you anywhere close."

From Stickman, Imagineers started pushing the robot into the shape of a human and began to work in multiple axes. Dohi admits that the human-shaped robot was "a pretty rough looking thing." It was all pneumatic, approximately 150 lb, and it did not have body shells on it. The current version is a much more polished robot. It was a two-year process to progress from the BRICK to the more-advanced robot iteration.

The giant leaps forward are still just scratching the surface of what WDI will be able to do with robots in roles that are too dangerous for human performers. "You would never put a stuntman in the parks to do show after show, six to 12 times a day, where they are being thrown 65 ft in the air, which is what our

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WDI Imagineers (from left) Victoria Thomas, John Larena, and Brian Orr evaluate an A-1000 *Audio-Animatronics* figure.

robot is doing," Dohi explains. "There's a 15-G acceleration on this thing that would make a human in a vertical orientation blackout. There's also a hit into the net that is about 12 Gs. If you land the wrong way, as a human, you've broken your spine. But if you look at what we have currently, it's about 4.5 s in the air. It's pretty neat to watch, but our shows are much longer than that, and you have to fill that time with other aspects of a performance. So we are not looking to replace human performers; we're looking to enhance entire performances."

With A-1000 technology, Imagineers are bringing *Star Wars* characters like Weequay pirate Hondo Ohnaka to life.

A-1000-times more animated

Disney parks have been renowned for their *Audio-Animatronics* figures that have brought characters to life including Captain Jack Sparrow, the Seven Dwarfs, and U.S. presidents. With A-1000 advanced robotics, WDI is producing the next generation of the A-100 *Audio-Animatronics* figures that were produced in the 1980s.

Improved movement and functionality resulted from replacing traditional hydraulic systems with electric motors. Most of the figures produced by WDI have been hydraulic, and, while they have been entertaining audiences for years, their performance degrades over time. Moving to electric motors presented its own set of unique challenges. For every motor, electric figures require a power and encoder cable, and they all need to route all the way down the figure and through the foot and the base frame. There is a large range of motion, so cable stress points are significant.

According to Kathryn Yancey, show mechanical engineer, Disney constructed its own actuators and removed many of the seals and exterior shielding, so they were nice and small. Those actuators were a perfect fit for the organic shape of the human body. For example, a wrist is long and skinny as is a hydraulic actuator. Since there are three functions in a wrist, Imagineers packaged three actuators into the wrist to make it move. The current electric motors are rectangular and have harsh corners, which presents packaging issues.

"With hydraulic, you can get a lot of punch from a much smaller actuator," Yancey says. "Now we're having to do a lot of rigid body dynamics and analysis in order to make sure that our motors and the bearings within our motors can have a long life because we are putting so much on them. They're going through a lot of stress, especially with our dynamic and speed requirements. With the torque we need at the speed that we need, we are definitely asking a lot more from our electric motors."

Both Yancey and fellow show mechanical engineer Victoria Thomas worked on one of the first attractions that was all electric—Frozen Ever After at the Norway Pavilion of Epcot's World Showcase. At the same time, Imagineers were working on the Shaman of Songs figure for Na'vi River Journey in Pandora–The World of Avatar at Disney's Animal Kingdom.

"Both projects were breaking all kinds of new ground," Thomas elaborates. "The Na'vi Shaman was aiming for top of the line—every bell and whistle—and Frozen was aiming for as much functionality as possible with more common-grade materials so you could afford more stuff. Between those two projects, we were able to learn a lot about what works well with electric figures, and we took all of that information and incorporated it. Both projects were pretty expensive, so we asked, how can we develop something that's a little more generic, a little more off the shelf? If a project team comes in and says, I need some human figures—I'm not exactly sure which humans—I just need them to be a reasonable human size and I'd like to just buy them. I don't want to worry about having to spend years designing these complicated things; I just want a tall guy and short lady. I want them to stand and to give them a couple minutes of performance. That's kind of where our project kicked off with the A-1000."

The A-1000 *Audio-Animatronics* project focuses on what Thomas terms "human humans," those with proportions falling between a 5-ft, 5-in female and a 6-ft, 2-in male. Examples of some rides that feature figures with these types of dimensions are Pirates of the Caribbean and some of the new *Star Wars*: Galaxy's Edge attractions. The idea is to cut down the time it takes to design new characters while still providing high functionality.

"We wanted to take that idea of having a kit of parts and being able to create a new character from those," Yancey explains. "We are creating subassemblies where you can defunction your figure. A function is what we call an articulation point, like an elbow. We sum up the level of complexity of a figure off of how many functions it has. You can define a price based off of function. With the subassembly, we've broken out these

Groot welcomes guests to Guardians of the Galaxy–Mission: Breakout! at Disney California Adventure.

key functions that you can pair with a head or pair with just a torso, and it's not necessarily like one and done. You can have the option, like a menu—we are calling it 'configurable in CAD.' You have your CAD designer or engineer that can use this library and you will have some design time to create your new character based off what creative gives you but it's significantly less time spent in design."

The characters Hondo Ohnaka and Kylo Ren in Galaxy's Edge are all examples of first-article A-1000 figures. Both are the standard 6-ft, 2-in male and have the same assemblies along with slight variations for their specific characters. But in terms of creating the figures, Imagineers are able to design once and produce nine times. Since there are often great variations between characters' faces, heads are their own stories. As a result, the A-1000 program came up with a simple head that contains 10 functions, but the functions can be adjusted depending on a character's unique need.

"You recognize that people will want to adjust the range, so we're providing as much range as we can for every function," Thomas adds. "There's a lot of changes that trickle down like a domino effect: How much longer do my cables need to be? What do the shells that cover the mechanism need to be shaped like? Do they need different clearance cuts? What kind of costume adjustments need to be made? It ends up affecting a lot of things. While we have tried to provide for every scenario, there's always going to be more that come up."

Dealing with the adjustments and challenges of working on the A-1000 project is a reward in itself, Thomas says. "One of the biggest reasons that I wanted to work here, as opposed to the aerospace or automotive industries, was because if I started as an intern in those industries, I would be doing double checks on someone else's work, paperwork, or the mundane for years until I proved myself competent enough to be able to handle minor design work. As an Imagineer, every time I walk out into the shop and see the Hondo figure, my jaw drops even though I know everything that's going inside of the figure."

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Star Wars: Galaxy's Edge offers the opportunity to step into the cockpit and pilot the Millennium Falcon.

Elsa, Anna, and Olaf are "electric" in Frozen Ever After at the Norway Pavilion of Epcot's World Showcase in Walt Disney World.

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Big ideas: The sky's the limit

Craig Causer

The genesis of any Disney park, attraction, hotel, or cruise project begins with people—creative and diverse and with varying perspectives. These people, Imagineers, are involved with everything from design through delivery—and the earliest phases are Blue Sky. Contrary to popular belief, Blue Sky is not a Walt Disney Imagineering (WDI) department; it's a phase of a process where Imagineers explore all the possibilities of what an experience will be, whether it's an attraction, a restaurant, a hotel, a ship, or even an entirely new park. The approach focuses on putting together interesting and creative people with different perspectives, giving them meaningful challenges to solve, and then removing barriers so they can create the next big thing in theme park entertainment.

"It was Disney Legend and famous Imagineer Marty Sklar who said, 'There's nothing more frightening in the world than a blank sheet of paper,'" recalls Josh Gorin, creative development executive at WDI. "The truth is that we rarely start with a truly blank sheet of paper. Imagineers often work with our site operations, business, and market research teams to understand the needs we are trying to solve. We start with writing down the requirements and the wish list, and that absolutely informs our development. That being said, we also like to have a portfolio of projects in Blue Sky, some of which are heavily informed by needs and others that are less directly informed by immediate needs but are a bit more strategic and high level. No two projects are truly the same but, at the end of the day, what Imagineers do is create experiential entertainment—entertainment that you touch, see, feel, and walk inside. Blue Sky is about exploring the next great thing that is really going to blow our guests away."

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BACKGROUND—©DISNEY; NAVI SHAMAN—©DISNEY

Disney has a history of taking technologies before they have been made available to the consumer market and putting them in its parks. One example is the Indiana Jones Adventure at Disneyland, which uses an early prototypical form of Wi-Fi.

The original Hatbox Ghost in the Haunted Mansion attraction existed for only a short time because its vanishing and reappearing head did not produce the desired effect during its initial implementation. With the advancement of technology, Disney was able to reintroduce the Hatbox Ghost in 2015 during Disneyland's 60th anniversary celebration.

While there is a time to evaluate the economic and technical feasibility of an idea, this does not intrude on the early Blue Sky process. The initial phases focus on "generating mode" and not "editing mode," Gorin explains. Prior to discussing specific ride systems, control schemes, or formats, Imagineers tackle questions including

- What is the experience you are trying to create?
- What is the core concept of this thing that you want the guest to experience?
- Why is it fun and compelling?
- How do you want the guest to feel?

Addressing these queries among collaborative teams creates a peer review process that often strengthens ideas.

"There is an incredible importance on the interplay between creative and technology and between concept and engineering," Gorin adds. "Imagineering really is a place that lives up to its name of *imagination* and *engineering*. We believe the art and creativity and the technology, science, and engineering are so deeply interlinked that you cannot separate them. I think there's a misperception that somehow someone goes off and draws a pretty picture and then an engineer figures out how to make it so. What we have discovered is that the best and most innovative ideas come when that creative artist and the engineer are sitting side by side at the table together, working through an idea. And, really, everyone has that creative potential within them. Engineers, illustrators, and writers just express it through different kinds of deliverables."

Dream teams

The most important part of managing the Blue Sky process, according to Gorin, is casting. Great people are required to come up with amazing ideas, and those people must be consistently supported along the way. With this philosophy in mind, WDI typically organizes teams into portfolios that focus on a particular Disney franchise, park, or type of experience, like a cruise ship or a hotel. These portfolios of Imagineers, comprising both creative and technical-minded people, work on delivering projects. Often, requests or opportunities are submitted by parks or properties, and diverse teams are assembled to brainstorm ideas without editing, criticism, or a significant focus on feasibility, just to see the breadth of what is possible.

Going forward, a team may be assigned to work through those ideas,

find common themes, see what resonates the most, peer review it with a few other teams, and develop some concepts. Those concepts may be evolved a little further, for example, with some form of visualization such as a 3D model, a piece of concept art, a sketch, and a physical model, and then a story treatment may be written. This peer review and evolution process can lead into a holistic creative pitch that describes the details of an idea, and it's at that point when additional subject matter experts are brought in to look at aspects such as site feasibility, economics, engineering, and architecture. Teams then put together a presentation that aligns with business, marketing, and consumer insights partners to ensure that the idea is both creatively exciting and meets the actual need of Disney's operating business. If it passes muster, a pitch is presented to senior leadership and then put on the slate, or "menu," to ultimately to go into production and be built.

"Almost every attraction we build has some amount of invention—sometimes it's a little and sometimes it's a lot," Gorin notes. "We don't wait for the technology to be perfect, but we need it to exist. If you look at Indiana Jones Adventure at Disneyland, it used a very early prototypical form of Wi-Fi before it was a consumer standard. We do have a history of taking technologies before they have been made available to the consumer market and putting them in the parks first. I would imagine that many guests had their first face-to-face video conversation on a video phone at Epcot or rode their first monorail at Disneyland. A big part of the Blue Sky process is almost turning on your own naiveté and saying, 'I'm going to think big about what I want to achieve and what I want people to do, think, and feel. Then once I get something that's truly compelling, I'll figure out how to do it'."

Taking the time to shine

Sometimes, regardless of the will and effort, ideas cannot be realized because the technology has not yet caught up to the concept. Walt Disney conceived the idea of Space Mountain, but it failed to be built during his lifetime because the technology didn't exist. Another example is the Hatbox Ghost from the Haunted Mansion. The ghost was an original figure in the Haunted Mansion that only existed for a short time before being removed. The concept was that the character's head would disappear, reappear in the hat box the ghost was holding, and then disappear again only to find its home back on its body. With the advances in technology over the years, Disney was able to reintroduce the Hatbox Ghost to the Haunted Mansion in 2015 during Disneyland's 60th anniversary celebration.

While a Blue Sky concept may or may not be realized in the current landscape of the various Disney parks, individual ideas never truly die. "Ideas are important and powerful, but they are not precious," Gorin says. "You can love them and care about them and want them to succeed but also be okay with knowing that maybe it just wasn't its time and possibly it will come up again in the future." WDI houses

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Some of WDI's big ideas are available to view at the Blue Sky Cellar located at Disney California Adventure.

hard drives, servers, drawers, and racks containing thousands of ideas—more ideas than you can build in a lifetime, Gorin adds. By saving the art and the presentation, sometimes even recording the idea pitch itself, Imagineers can access that information in the future when the technology landscape has taken another inevitable generational leap.

The WDI R&D philosophy is best encapsulated by a quote from science fiction writer Arthur C. Clarke that is scrolled on a wall in the R&D offices: "Any sufficiently advanced technology is indistinguishable from magic." Disney is in the business of creating magic for people, and, very often, it's an intense technology powering that experience.

"When we've done our job correctly, guests aren't thinking, wow, look at that technology; they are having a truly emotional transformative experience," Gorin explains. "That's a big part of what we do here at Imagineering—hide the complexity in order to bring through the meaning and the story and ultimately a really powerful guest experience."

Cutting-edge R&D

One of the more moving guest experiences can be witnessed at Walt Disney World's Animal Kingdom, where the lush sights and sounds of the natural world of Pandora belie the technology beneath its surface. On the Na'vi River Journey, guests board a boat and ultimately come in contact with the Na'vi Shaman of Songs, an *Audio-Animatronics* figure that R&D Studio Executive Jon Snoddy describes as "a Moonshot mission for us." The Shaman is an extremely complex figure containing 45 functions in the head alone and twice that number in the body. (Think of each muscle movement being one function, for example, an eye blink or a jaw opening and closing.)

"The Na'vi Shaman was a fully electric figure, and we knew that we had to have precise control of everything," Snoddy explains. "We said, let's build an ultimate figure using these new electric actuators that we can now use. In the past, we would go through a lot of trials first. You would try something, dial it down a little bit, and build another version of it. This was the first one that was virtually all done electronically. It was all done in CAD and with a digital workflow. That means in assembling it, it's no longer people with hacksaws, files, and sanders making parts. You go up and design the part, run it through your simulation to make sure finite element analysis tells you that it is strong enough, then you have one made and go drop it into place and screw the screws in and you know it's going to fit. We took that all the way through the process, and it was one that sort of advanced our whole workflow. It's way more complex than is needed for most figures, but we wanted it to be."

This Shaman project eschewed any parts from the previous generation of *Audio-Animatronics* figures, and almost no concepts crossed over. It was a new way of thinking in terms of moving from hydraulic to electric actuators. In the past, there was a hydraulic cylinder that would act on a space frame, and with this system, the motors became the joints. If super-high energy density is required, hydraulics are still useful, but WDI is building a whole new generation of electric motors in-house that possesses significant energy density, and it can now utilize them to achieve the required performance.

"If you look at how the Na'vi Shaman was done, it was all R&D for the alpha figure," Snoddy says. "By the end of it, it was probably around 50% R&D, and the actual figure that went into the park was 90% the

The Na'vi River Journey Shaman is a very complex figure that contains 45 functions in the head and twice that number in the body.

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Ideas do not start with technology; the technology has to "earn its own way," says Snoddy.

Animation [department] team. That's how we want to do things."

Collaborative R&D

The WDI R&D studio comprises three groups, starting with Disney Research, which looks at emerging science to push the boundaries in areas such as materials and artificial intelligence, as applied to Disney's problem set. The Research group performs open-ended experimentation that often ends up in an advancement that is interesting and gets passed on to another group within the R&D segment.

The second segment, Advanced Development, is a group of artists, engineers, and scientists figuring out how to apply what is going on in all of the various projects and the philosophy and the strategy that drives each one. Imagineers in Advanced Development take emerging technologies from Disney Research and package them into ideas that could be used by designers of theme parks or consumer products. You can't just hand someone a machine-learning algorithm, Snoddy explains, so Advanced Development will show an artist or designer what a particular technology can do. The third group is the Tech Studio, and it builds the hardened code needed to run the parks and their attractions.

Imagineers that call R&D home are required to excel in various disciplines as well as have the ability to work in a highly collaborative environment. "For everybody here, we can drop them onto a project and they add value, and that was what got them in the door," Snoddy says. "You can be a really great programmer, controls person, a brilliant mathematician, a great mechanical engineer, but that's not enough. We are a really collaborative organization, so this is not a place for those people who are not very social but who are brilliant. They may think so very deeply about a subject, but it really takes an organization around them to extract the value. What's important for us is the ability to collaborate, somebody who likes to be on a team, work with others, and is curious about everything. The world changes so fast, and we can't just go hire someone who is a specialist in every new thing."

The evolution of the Haunted Mansion is proof that ideas never truly die.

Earning its own way

Despite the high level of technical proficiency in the R&D building, the notion is reinforced that ideas do not start with technology; the technology has to "earn its own way," according to Snoddy. For instance, Imagineers are not starting with virtual reality (VR) and dreaming up ways to use it for an attraction. In Snoddy's mind, VR has not earned the ability to serve as the centerpiece of an attraction.

"It's still isolating—I mean, it's unique and it's amazing—but it's very low resolution," he reasons. "People get sick from it, and it's really hard to track people. Imagine you are there with your kids in a Disney attraction. You can look over, and just in a millisecond, you can see that she's scared, he's freaking out, or they're both having a great time. You can just see that in an instant, and that connection is part of your personal experience. That's really what a Disney park is about."

One of the more noted technologies that has been utilized in the parks is free-ranging vehicles that can drive anywhere within a specific attraction. Such vehicles are currently developed with CAD, and there is a model of every single one in production. R&D Imagineers can take a model, run it through an automated system to produce a file that can run in VR, and designers then sit together on a vehicle that is the same size and shape as the one in which guests are situated. It travels the same speed and exerts the same G forces, and Imagineers can begin to design that experience from the inside out.

This type of experiential testing results in more questions: What if a turn is moved farther down a few feet? What if the audio cues begin a little earlier? The level of detail produced by these VR experiences was previously accomplished through the use of storyboards and models, which are still relied upon, but the advanced technology provides greater insight into how designers can mold the physical experience of an attraction.

No limits

At WDI R&D, the job is ever moving forward, and Imagineers are encouraged to examine pie-in-the-sky ideas that are confined only by the limits of their imagination. It's more following the path of exploration than adhering to top-down mandates.

"I report to the president of Imagineering, so I'm expected to be in those planning meetings where we think about what's going on down the road," Snoddy says. "If you tell us what you want, that just limits so much of our thinking. What you really want to do is tell us, of things going out the door, what you really like, and we can reflect that into our own complex feedback loop. The stakes are high, but we get to kind of explore everything as long as what comes out the door is amazing."

About the author

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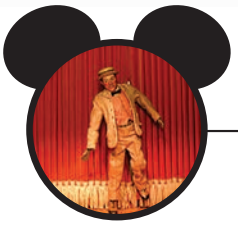
Walt Disney *Audio-Animatronics* Timeline

EARLY 1950s

EARLY 1950s: Walt Disney purchases a mechanical bird while vacationing in Europe. It serves as the inspiration for *Audio-Animatronics* technology.



1951

1951: Work begins on Project Little Man. Imagineers and *Audio-Animatronics* pioneers Roger Broggie and Wathel Rogers create a miniature figure that is programmed with cams, cables, and tubes to mimic tap-dancing routines performed by actor Buddy Ebsen.

1963

1963: Walt Disney's Enchanted Tiki Room opens at Disneyland in Anaheim, California, becoming the first show to feature *Audio-Animatronics* technology.

1964

1964: The world's first fully animated human figure, Abraham Lincoln, debuts at the New York World's Fair in the attraction Great Moments with Mr. Lincoln. *Audio-Animatronics* figures are also present in three other World's Fair shows designed and produced by Disney: Carousel of Progress (featuring figures animated using a programming harness, a precursor of today's motion-capture systems), Magic Skyway, and "it's a small world."

1964: Two *Audio-Animatronics* birds, Robin and Umbrella, appear in *Mary Poppins*. Walt Disney reinvests profits from the film to create MAPO (a name derived from MAry POppins), an organization within Walt Disney Imagineering dedicated to creating and innovating *Audio-Animatronics* figures.

1965

1965: Great Moments with Mr. Lincoln—featuring a duplicate *Audio-Animatronics* figure of Abraham Lincoln (since the original was still performing at the World's Fair)—opens at Disneyland.

1970

1970: *Audio-Animatronics* technology enters the computer age with the use of the Digital Animation Control System, a computer-controlled playback system for Disney shows and attractions. Imagineers also begin employing the Anicon-Animation Console for animating and programming figures.

1989

1989: The first A-100 *Audio-Animatronics* figure, the Wicked Witch of the West, debuts as part of The Great Movie Ride at Disney's Hollywood Studios (then known as Disney–MGM Studios) at Walt Disney World in Orlando, Florida. The A-100 figures incorporate compliance technology that gives the characters more fluid and realistic movements.

Mr. Potato Head (2008)

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1992
1998
2002
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2007
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2014
2017
2019

Na'vi Shaman of Songs (2017)

1992: Pirates of the Caribbean opens at Disneyland Paris. The attraction features sword-fighting figures.

1998: Hopper, the grasshopper from *A Bug's Life*, is the most sophisticated *Audio-Animatronics* figure produced to date. Featuring 74 functions, the character appears in It's Tough to Be a Bug at Animal Kingdom at Walt Disney World.

2002: The first portable, all-electric *Audio-Animatronics* figure, Meeko the raccoon from *Pocahontas*, appears at Disney California Adventure. He resides in a basket carried by Pocahontas.

2003: The first totally autonomous *Audio-Animatronics* figure, Lucky the Dinosaur, is play-tested at Disney California Adventure in Anaheim, California.

2004: In Stitch's Great Escape at Magic Kingdom in Walt Disney World, Stitch becomes the first *Audio-Animatronics* figure to spit at guests.

2006: The yeti scares up thrills on Expedition Everest at Disney's Animal Kingdom. Standing more than 18 ft tall, the thrust of the yeti's arm has the equivalent amount of force as a 747 jumbo jet. It is the largest and most powerful *Audio-Animatronics* figure ever created by Walt Disney Imagineering.

2007: The Muppet Mobile Lab (tested at Disney California Adventure), featuring Dr. Bunsen Honeydew and his assistant Beaker, marks the first time that free-roaming *Audio-Animatronics* characters can interact and converse with each other as well as with guests they encounter along their journey.

2008: Mr. Potato Head in Toy Story Mania! (at both Disney California Adventure and Disney's Hollywood Studios) marks the first time that an *Audio-Animatronics* figure features lips with such a wide range of lifelike movements, can remove and re-attach a body part (his ear), and possesses digitally animated eyes that can look directly at the particular guest with whom he is conversing.

2014: The Seven Dwarfs Mine Train at Walt Disney World features ride vehicles that slow down so guests can spot *Snow White and the Seven Dwarfs Audio-Animatronics* characters appearing in various scenes.

2017: The Shaman of Songs is unveiled as part of the Na'vi River Journey attraction at Disney's Animal Kingdom. The Shaman is the most advanced *Audio-Animatronics* figure to date, containing approximately 45 functions in its head and twice as many in the rest of its body.

2019: A-1000 *Audio-Animatronics* take center stage with the opening of *Star Wars*: Galaxy's Edge at Disneyland. Hondo Ohnaka represents the next generation of lifelike, electric-powered figures.

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Inside the minds of two of Imagineering's most prolific creative executives

Craig Causer

The allure of Disney parks is fueled by both new and nostalgic attractions designed to build memories for the millions of guests who visit each year. Once inside the park gates, the sights and sounds created by generations of Imagineers come into view. If you look closely, you can spot tributes to the people who helped bring the parks to life. On Main Street, U.S.A. in Disneyland, Walt Disney World, and Disneyland Paris, the names of Disney luminaries are creatively embellished across the windows on the various buildings. "Open Since '55—Disneyland Casting Agency—'It Takes People to Make the Dream a Reality'—Walter Elias Disney, Founder & Director Emeritus" and "Center Street—Painting & Sculpture—Collin Campbell, Herbert Ryman, Blaine Gibson, Mary Blair, Dorothea Redmond" are just two of the fictional business facades that pay tribute to various Imagineers for all posterity.

You don't have to take a glide on the Haunted Mansion's Doom Buggies (where you can witness the disembodied head of former Imagineer Leota Toombs—a.k.a. Madame Leota) to get up close and personal with an Imagineer. *IEEE Potentials* sat down with two current Imagineers, Joe Rohde and Tom Fitzgerald, to pick their brains about topics including creating new parks and attractions, adapting to various cultures, and the importance of soft skills in the workplace.

BRAIN—©ISTOCKPHOTO.COM/GREMLIN, TOM FITZGERALD AND JOE ROHDE—©DISNEY

Into the wild with Joe Rohde

Joe Rohde is a portfolio creative executive at Walt Disney Imagineering. He has spent 37 years with the company, beginning his career as a model designer on Epcot and continuing with projects at Disneyland in Anaheim, California; Walt Disney World in Orlando, Florida; Disneyland Paris; and Aulani, a Disney Resort and Spa in Ko Olina, O'ahu, Hawai'i. Rohde led the team that conceptualized, designed, and built Disney's Animal Kingdom at Walt Disney World. He is also responsible for the creative design and content of Aulani. He spearheaded the team that designed Pandora–The World of Avatar at Disney's Animal Kingdom as well as the Guardians of the Galaxy—Mission: Breakout! attraction at Disney California Adventure in Anaheim.

In the process of developing Disney's Animal Kingdom, Rohde was instrumental in promoting a strong wildlife conservation message, including the development of the Disney Conservation Fund, which has

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allocated more than US$75 million to projects around the world. His work at Aulani involved significant cultural collaboration with representatives from the Hawaiian community to develop the content and artistic interpretation of the resort.

IEEE Potentials: **How do you approach the job in terms of creativity and authenticity?**

Rohde: I very strongly believe in using narrative structure as the fundamental organizational structure. A lot of people, when they talk that way, they're only talking about the product. We're going to tell a story, and obviously a story needs story structure, and we're going to have to provide some architecture of thought to build a story around. That's all true. But I'm talking about human nature and the way people process the world, how the brain is put together, how human groups relate to each other—all of that is also all narrative.

Part of what I try to work on is the story of the team itself. Who are we, and why are we doing the thing that we're doing? You're trying to build up a framework for future unknown decisions. You can't make these decisions yet; you don't know what they're going to be. With a big complicated project, if you attempt to meet these decisions one by one on the merits of the decision alone, you're going to lose narrative control of the project. Because the merits of individual decisions vary completely. Like, this is an economic decision. Is this one cheaper or is this one more expensive? This is a practical production decision. Which one of these is more feasible? This is a political decision, which is the most powerful person who wants to see something happen. So rather than contributing to a single idea, these things tend to pull an idea apart unless there's a center.

Before you make any decisions about anything whatsoever, you need a decision about why we assembled, what we stand for, and what the project is going to be about. I don't mean subject-wise; I mean as a value set. What this does is that you can actually create a really predictive model that says nothing about the material nature of the final product. You are not leading by telling people what to do nor are you telling them materially what the goal is because you want to discover what the goal is. Right? You're leading by telling them the underlying ideal behind any decision. What kinds of things is this project even meant to express?

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Rohde spearheaded not only the sights and sounds at Disney's Animal Kingdom but also the architecture of thought around which the park's story was built.

Keys to the Kingdom

IEEE Potentials: **How did the Disney's Animal Kingdom project start? This park was something entirely new to Disney and involved a lot of moving parts. How did that idea that we eventually see as a fully functional park come about?**

Rohde: You start with the subject: animals. It's not a theme; it's a subject. So, the first thing you need to do is say we have a subject, animals, which violates all of the existing themes that make a theme park work. They're not idealized, they're not predictable, they do not come from established narrative, they're going to be nonrepeating. These are all things that make a theme park work, and they're things that animals do not do. Therefore, if I'm going to create a theme park with this as the subject, I first need to create a new set of evaluative values that are consistent with those animals.

Before we did anything, we sat down for a long time—weeks—and worked on just getting to the bottom of animals. What do they mean to people: freedom, innocence, surprise, exoticism. This is what the project is going to be about. It won't really be about animals; it will be about these ideas that are inside the animals. We're going to find the ones that are consistent with the ability to build something.

We ended up with this little set, and you can see how it will govern future decisions. If my subject is animals who will not cooperate with choreography or planning because their behavior is natural, then the intrinsic value of nature itself must be one of the foundational values of this project. The fundamental untradable value of nature must be one of our foundational design values because our primary subject will not cooperate with any other value. If that is true, if our foundational value is the intrinsic value of nature, what then does that tell me about the nature of the space? Is my space more likely to be laid out in a geometric grid or in a symmetrical set of loops and curves? It's probably loops and curves. Is it more likely to be dominated by architecture or landscape? Probably landscape. Will

individual trees in that landscape be more likely to have a straight trunk or a crooked trunk? Probably crooked. None of these decisions have been made, but it is so clear as to the nature of what they would be because you have predicated them all on an idea. There's a small set of these ideas: the intrinsic value of nature manifested by dominance of landscape over architecture, dominance of asymmetrical form over symmetrical form, dominance of organic form over geometrical form.

IEEE Potentials: **When focusing on these core animal-based ideas, how much did unpredictability and conservation play into the conversation?**

Rohde: Another focus of ours was this sort of idea of adventure as the confrontational with the unexpected in the new. Since we have animals, unpredictability and surprise is also one of these ideas. So, buildings that look like they're not really maintained—if they were maintained that means they were under control and you couldn't have a surprise. In a place like that, would I expect my interaction to be scripted or unscripted? Probably unscripted. Because someday a giraffe is going to stand in front of a vehicle, and you're not going to be able to move. That has to be a good thing because it's going to happen inside of your story.

In the third set of ideas was this personal call to action. There's almost a moral obligation, if this is your story set, to tell people things so that they can make real decisions about how they fit in this world. All of that existed before any idea for any attraction whatsoever so that we knew how to filter ideas.

This goes back to this notion of narrative foundation. This is a story-making foundation that's very different from a linear task set or a checklist; it's more like the strange attractor in a fractal mathematical formula, where I'm going to write this little formula, and then I'm going to push go, and it's going to start to generate all these weird fern shapes. Then there's going to be all these little inflections, and I don't know what they're going to be. And if it comes up against an impediment, it's still going to be like ferns; it's just going to grow around the impediment. Whatever it is that this thing is, it's all one big idea, it all fits together, and you let that drive. That way, you can discover what it might be instead of starting at the beginning of a project, one that's going to be five or six years long or longer, and

(a) and (b) The construction of the Tree of Life at Disney's Animal Kingdom and (c) the finished product. The tree reaches 145 ft high and contains (d) 300 animal carvings.

try to predict what it's going to be.

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Rohde (right) put his Na'vi-sized shovel to the earth during the 2014 groundbreaking of Pandora–The World of Avatar.

IEEE Potentials: **During the design process, how do you determine what is feasible? For example, in Disney's Animal Kingdom, there are boundaries that people can't see and that the animals can't get past. Another instance was the idea behind Expedition Everest, which incorporates switching roller coaster tracks and a giant animatronic yeti. How long does it take to decide if those are things you can actually accomplish?**

Rohde: The less you want to innovate, the faster you can go, which works great in a lot of industries. A lot of industries can go a long, long time with small incremental adjustments to a predictable product. This is not one of those. The entertainment industry is predicated on novelty; it's predicated on something being patently, obviously rich and new. You have to surprise people. That means, first, it's going to take time. We've gotten better and better at previsualization tools. Even when we were doing Disney's Animal Kingdom, we were one of the first parks to do a big digital model of a section of the park. We did the entire safari as a huge, CAD, topographic drivable model. But back in the day, the file was so big that we had to pick a ride path, send it away for like 24 hours to grind out fixed video of a particular thing, and then we could watch it. We were previsualizing. So, you previsualize as much as you can: models, digital models, mock-ups, tests, full-scale prototypes—anything you can do to help get as close as you can to what you are trying to create.

The other thing I think you try to do is isolate the arena of innovation. Where exactly is the crucial innovation in this thing? Maybe let's not have others; let's just make sure there's one crucial innovation that we can deal with so we can get it done. With Expedition Everest, the one innovation that allows the ride to exist is to take the principle of a track switch, which exists—yes, there is a track switch that allows a coaster to be diverted from one track to another. There did not exist a track switch built on a curve that can allow a fully loaded coaster moving at high speed to be diverted to another track and to do so by flipping over at a very high speed. If that can be made, which is a series of really mathematical engineering questions, then we have an idea. This idea's validity is based on stopping and going backwards, and we can only do that with this track switch. Really, in the end, the rest of the coaster is very coaster-like. It's all been done except for this, but if you can do this, you can do something no one has done. They won't see it coming, and they won't expect it because they don't have it in their framework of experience. You try to isolate what is it about this [idea] that is unique and protect it by not having unnecessary innovations that are distracting from the core.

The strength of soft skills

IEEE Potentials: **Soft skills have been important in the progression of your career. Talk a little about why these types of skills are so essential.**

Rohde: Projects live and die on the basis of the dynamic of the team itself. It's the ability to communicate, negotiate, describe, enlist—to get people to want to be on your team—which have only so much to do with what you're building and another whole thing with who are these people, and do I want to spend four years of my life for at least eight hours a day dealing with them?

You have to think in terms that these are huge enterprises. Huge enterprises get done because of relational issues. For example, I need those park guys to actually ask for this thing. It's not a big surprise if I ask for this attraction. I'm a designer, of course I'm going to ask for an attraction. I need to be a service provider in this relationship. It all goes together, you cannot take it apart, you can't extract the physical product from the social milieu in which it's going to get done because the only way it's going to get done is through this milieu of people working with each other. The product does not exist except through human agency. The human part of a product is superimportant.

IEEE Potentials: **How can students improve upon their own soft skills?**

Rohde: Certainly, practice will increase familiarity. Phobias like speaking in front of a group will lessen by actually doing it. There are a couple of principles. I used to

be a teacher. One of the core principles of teaching is you have to be able to shift from thinking in terms of what you know, and simply trying to dump knowledge, to imagining all of the ways in which some other person would fail to understand or be emotionally gripped by [a concept]. So, forget what you know; forget how smart you are. Forget how much sense this thing makes that you're trying to describe and flip it completely over and go, okay, imagine I was not me at all. I am some other kind of person. I exclusively only care about the financial implications of this decision, for example. How would I be looking at this and what needs to be said for me to understand it and to feel some sense of solidarity to it? Or I am culturally predisposed to be enthusiastic about completely other things. I don't care about this subject; what would I have to perceive in this to be able to find a place in it?

IEEE Potentials: **You've given presentations in front of some very large audiences. How do you approach the process of communicating big, technical ideas?**

Rohde: When I'm presenting, I sort of have two modes: one in which I'm trying to build confidence; I want you to understand that this is a responsible idea. It can be done. Then I can indulge myself and go, now I can be more expressive about how this part is really cool, this is the part that's super exciting, never been done, really love it, and I'm perfectly happy to tell you that this is my favorite part right here. But I've also taken the time to say don't freak out, this is feasible, responsible work has been done, just so that you're relaxed enough that I can now indulge myself and talk about the part that I'm really interested in. That's fine to do—it humanizes and personalizes, and it attaches you to the idea so that it transcends just being an object in the universe.

Tom Fitzgerald: Looking to the stars

Tom Fitzgerald is a creative executive at WDI. He is currently responsible for the creative direction of two portfolios: Disneyland Paris and part of Epcot at Walt Disney World. Born in New York, his dream of becoming an Imagineer began when he saw the Disney attractions showcased at the 1964–1965 New York World's Fair. Fitzgerald began his Imagineering career in 1979, and he has presided over the creation of more than 400 media projects across the globe including Star Tours, Soarin', Mickey's PhilharMagic, Cinémagique, It's Tough to be a Bug!, and MuppetVision 3D.

Fitzgerald was the writer–producer for the original Star Tours attraction and continued as the creative director of Star Tours–The Adventures Continue, both of which provide a 3D, motion-simulator flight experience through the *Star Wars* universe. For Disneyland Paris, he led the Imagineering team in the creation of Ratatouille: The Adventure as well as the Bistrot Chez Remy restaurant.

IEEE Potentials: **Talk about your contributions to Star Tours. What was it like not only trying to get a *Star Wars* ride up and running but also creating an attraction that met with George Lucas's approval?**

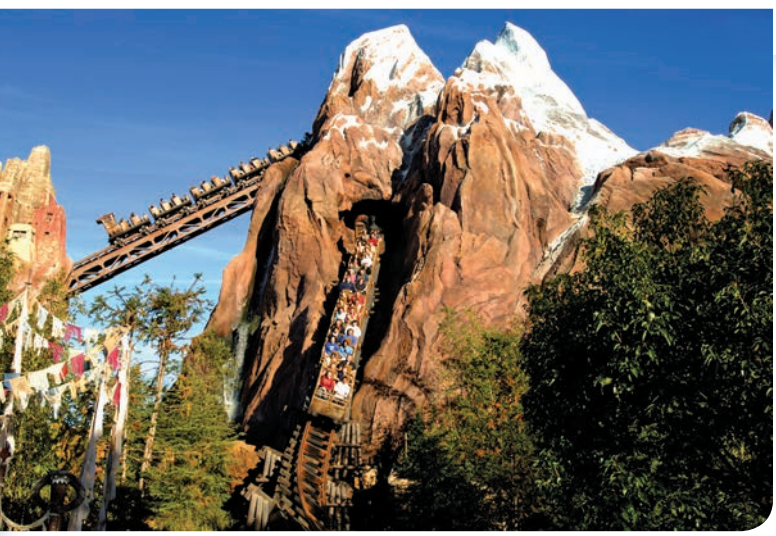
Fitzgerald: The one thing that I'll probably be remembered for when I retire is Star Tours. It was a big deal and a fun collaboration. George Lucas was the Walt Disney for me when I was a young adult. I was a huge *Star Wars* fan. I was the writer and show producer for Star Tours, and Tony Baxter [former senior vice president of creative development at WDI] was the show director. We worked very closely together.

What was interesting about Star Tours was something that came along later. It was a step into simulation, which was a new form of entertainment, a motion-based simulator that found other uses and continues to find uses in simulation attractions. When we created it, the technology was there for the motion base, but for the show portion, we weren't quite ready for video yet, so we had to use film. Our Imagineers had to figure out how to take a 70-mm projector and a loop cabinet, which is the thing the film runs through instead of a reel—it's a big loop of film that can continue all day. We had to figure out how to put a loop cabinet and a projector on a motion base that would be rugged enough to run all day long, every day. That was amazing for its time period.

What we thought was so interesting about Star Tours initially was because it was a film, you could change the film and change the show. Well, we never did because the attraction was so popular for so many years, the parks would say, we don't need to change it. And we said, yeah, but we can do more with it.

IEEE Potentials: **At what point were you able to enhance the ride and include additional adventures?**

Fitzgerald: It wasn't until George started doing the prequels that we



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Expedition Everest's innovative track-switch experience provides guests with a high-speed Himalayan adventure.

said, now he's changing the story. By the time we had done Star Tours, he had wrapped episodes 4, 5, and 6. We opened in 1987, and *Return of the Jedi* came out in 1983. So George was done. For George, the interest of Star Tours was that it would keep his franchise alive until such time that he made any new movies, and at that point he wasn't planning on doing any new ones. Every day at Disneyland, and in Florida and Tokyo, R2-D2 and C-3PO—along with that music and those adventures—would be playing in front of the public. So, his franchise wouldn't fade away.

When he started the new movies, it was a chance to say he's now adding more stories. To stay relevant, we need to change as well. When he was doing Episode 1, he called us and said, "I know what Star Tours should be from the movie I'm making." We went up, and he showed us the pod race. That's all he showed us. We didn't know how it fit into the story, so we actually worked up storyboards and got the whole story together and then stopped and said, well, what's going to be in number two and then decide if there is a stronger ride in that film. As you can imagine, after he was done with number two, we naturally asked, what's going to be in number three? By the time he finished three, we now had six films, so we asked, what one ride are we going to do? That's when, for me, it was a very "Imagineering thing" moment: How many Imagineers does it take to change a light bulb? Why does it have to be a light bulb? So, we asked, why does it have to be one ride? Because now that we could use video, we could do more than one.

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Fitzgerald served as the writer and show producer for Star Tours. Here, he is getting up close and personal with a picture-perfect Gran.

IEEE Potentials: **What were some of the most important decisions made regarding Star Tours and its evolution?**

Fitzgerald: For me, what's important about Star Tours, when you ask what do you think you've done that's been important for the industry, it was less about the simulator the first time and more about saying that in the time that we created Star Tours and went back to do Star Tours–The Adventures Continue, the way guests used the parks had changed. When we were planning Star Tours, we were still in an age that had ticket books, where you would pick your e-ticket out and go use it. That changed with [former The Walt Disney Company Chairman and Chief Executive Officer] Michael Eisner and [former President] Frank Wells pretty quickly after they came on board.

What happened was that once you took away the ticket books and went to the unlimited ride-whenever-you-want model, it became a buffet.

©DISNEY/LUCASFILM

Star Tours allows guests to face (and flee) Darth Vader.

And once it became a buffet, people could get off and get right back on it. They could just churn through it. When I was a kid, I grew up on the East Coast, and when going to the parks, you had to really look at those e-tickets and say I only have one more ticket, am I going to do Haunted Mansion or Pirates? I had to make a choice and only get to do one, and it would be years before I would get to come back. Once you could go on it again and again, the fear was that people would say I've done that. Well, that can't be possible because these things cost a lot of money, and they have to last a very long time. The idea of having the branching storyline was that if we not only have new adventures but we figure out how to make it even more random, then we can have lots of different combinations of the show, which means it's going to take you a lot more rides to see everything. And even once you have seen them all, you never know which combo you're going to get.

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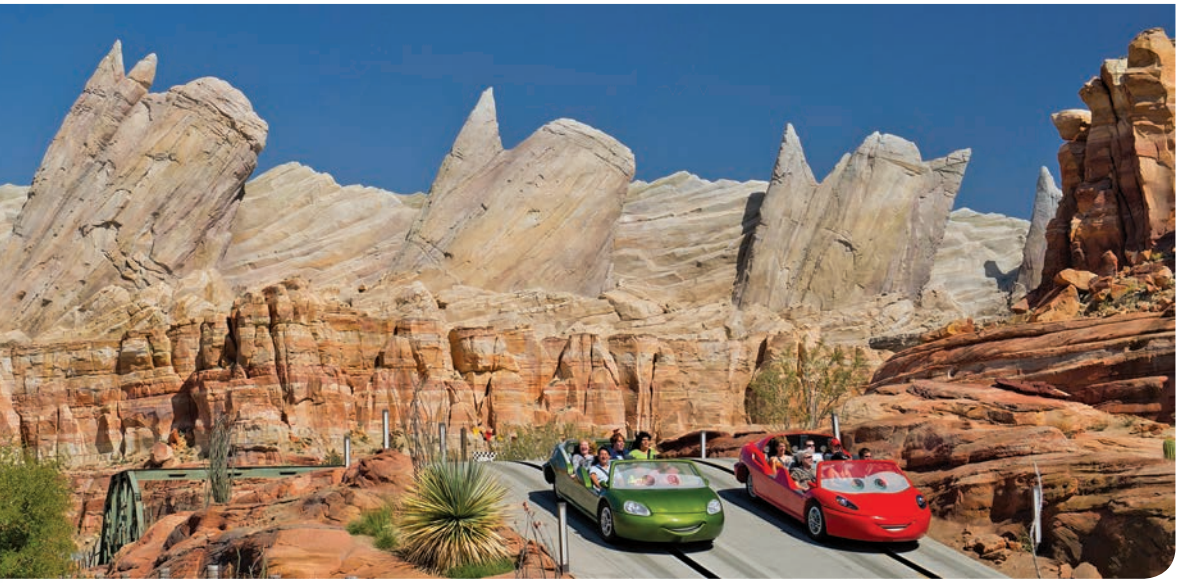
Fitzgerald (center) gets a rat's-eye view of the culinary delights featured in Ratatouille: The Adventure at Disneyland Paris.

***IEEE Potentials:* How has Star Tours influenced the theme park attraction landscape?**

Fitzgerald: The way I laid out Star Tours–The Adventures Continue is like a slot machine: I'm going to have different openings, different act ones, different transmissions, and different finales, and each of those segments in each wheel will be exactly the same length so that you can, like a slot machine, pull the wheel and get different combinations, and they would line up through the hyperspace jumps. You would be able to have 54 combinations, and that, to me, was the breakthrough of The Adventures Continue. Because in a world where people are absorbing our product with annual passes and much more, how do you keep it flexible? How do you keep it surprising?

I think that's something you see more now in things that we're doing in the parks. There's *The Nightmare Before Christmas* overlay at the Haunted Mansion in the parks, there's an "it's a small world" holiday overlay, and in the *Ratatouille* ride in Paris—depending which vehicle you are in—you get slightly different versions of the show. That is really important for our business because flexibility and changeability have to be part of how we look at our projects now because we have an audience that just churns media so much, and we also have so much



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Cars Land was a game-changer for Disney parks in terms of "going big," Fitzgerald says.

media coming out from the company that you want the ability to say, "I'd like this attraction to have this Marvel story now, but now that a new film has come out, I want to do a ride based on those characters and stories." Alright then, I need to think about the ride being like Star Tours. Somehow, it has to be media based so I can change out segments, and it has to be on a scale like Avatar Flight of Passage, which is a modern-day version of Star Tours that is unbelievable in its immersion and programming. We all build on what's been done before us and learn from that and also from what the parks need.

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Fitzgerald (left), who has been a driving force behind Disneyland Paris, focuses on a model designed to bring a *Ratatouille* attraction to Epcot in Walt Disney World.

Change and adaptation

IEEE Potentials: **What are some of the significant changes you've seen in the parks over the years?**

Fitzgerald: Cars Land [at Disney California Adventure] was a game-changer for us in terms of "go big." We are shifting from "theme" park to more "franchise" park, in a way, and I don't think that's a bad thing. What I think the guests are saying is that they want to be more immersed in the world. I don't want to go through a New Orleans facade and then be in Pirates of the Caribbean. I want to be in a pirate land. I don't just want to go into Star Tours and see those things, I want to step into *Star Wars* land or into Pandora.

I'm sure that there are many of our guests who would say their favorite Pixar film is something other than *Cars*, but the audacity of stepping into Radiator Springs just makes you smile because you cannot believe that you are in Radiator Springs with all of that rock work. And then you go on Radiator Springs Racers, have fun on the Mater's Junkyard Jamboree ride, and go to Flo's V8 Cafe for some food. The best comment I heard came from a kid when it had opened. The boy asked his dad, "Is this where they filmed *Cars*?" It was so believable to that kid that he thought there was a movie crew that came in and filmed the movie there.

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Guests are immersed in Radiator Springs during a spin on Luigi's Rollickin' Roadsters in Disney California Adventure.

Rohde signs a beam during construction of Pandora–The World of Avatar in Disney's Animal Kingdom.

IEEE Potentials: **What are the attractions and interests that are unique to the region that have been integrated into Disneyland Paris? How do you adapt to a culture?**

Fitzgerald: How do you adapt to a culture? As we have grown, we've gotten better at it. There are things that are universal. Physical things are universal. Space Mountain is going to be pretty popular wherever you drop it. When you get into more narrative stories, more of a boat ride or a theater show, you have to be a lot more careful and ask what kind of storytelling is going to resonate with this audience? What properties are they interested in?

They're not the same everywhere. In Paris and elsewhere around the world, we have groups in our company that perform studies focused on franchise strength in a marketplace. I'm so old that when I started with the company, and for many years, we didn't have a live-action picture that was successful that we could base a ride on. We had animation that we could, but now—between all the Marvel films, Lucasfilm, Pixar, feature animation, and Fox—we have so much [intellectual property] that we have to be more selective now when we look to build something that could be around for 50 years.

Ratatouille was a natural for us; it's a Valentine to the French and to Paris and to food. We really should do something with it for this audience. I never thought it would go anywhere else, and now we're putting it in Epcot. You never know where things are going to go.

IEEE Potentials: **But adaptation is not just matching intellectual properties with cultures. How has Disney approached moving technology forward?**

Fitzgerald: Walt hated the fact that, in his day, when he released a movie, it was done, and there were things he wanted to change and he couldn't, and it would never be fixed. Today, filmmakers get to go do their "special edition" and fix it. But he loved the park because he said it was a living thing and would evolve. Walt was trying to figure out what it was that the guest wanted to come and step into.

As the park got more sophisticated, his team had to invent ride systems that could carry greater numbers of people because the park was getting so popular. You could no longer have a simple ride that could handle 400 people per hour. You needed 2,000 or 3,000 an hour, and that required inventing ride systems like Pirates of the Caribbean, "it's a small world," Carousel of Progress, and Haunted Mansion. All of those were ride systems that really got their start at the New York World's Fair, where Walt realized that a fair that was only open a few months was going to have enormous crowds—much bigger than Disneyland. He would have his engineers figure out how to move more people through the shows.

Then, of course, Disneyland got the benefit of all of that when all those shows came back. Suddenly Pirates went from a walk-through to a boat ride, and the drive system that moved the Ford car in the Ford ride became the same ride system that he used for the PeopleMover at Disneyland, and a version of it was used for Adventure Thru Inner Space and then the Haunted Mansion.

Balance and divergence

As veterans of the themed entertainment industry, Rohde and Fitzgerald are adept at juggling the myriad issues that go into large-scale projects. "The business we do is a bit like fly fishing," Rohde explains. "I'm working on about four to six projects right now. There are teams, and they're working and talking. We have no idea in the world if these are all going to happen yet. And yet, as far as we know, they are feasible and affordable. And we vouch for the fact that they seem interesting. But that does not always continue to bear out as you go deeper and deeper into a model. As it gets later in a project, you have to be more nimble about reacting. You have to decide whether I'm going to fight this through, or do I stop it, adapt, and go around [the issue]?"

Fitzgerald adds that replication versus diversification is a discussion that is often revisited. "There's obviously an efficiency in replication, and it started with Walt Disney World's Magic Kingdom," Fitzgerald says. "You were going to have a Haunted Mansion and "it's a small world" attractions—you can't imagine not having those. Will every park build everything exactly the same? I don't think so, and they shouldn't. Part of the fun of going to different Disney parks around the world is seeing different things."

About the author

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The wonder of Imaginations

Craig Causer

One of the most popular Walt Disney Company adages is "If you can dream it, you can do it." [It's a quote often attributed to Walt Disney but actually coined by current Walt Disney Imagineering (WDI) Portfolio Creative Executive Tom Fitzgerald for the Horizons attraction at Epcot.] Regardless of the source, sustained success requires that any industry attracts the next generation of dreamers and doers. To that end, in 1991, former WDI executive Marty Sklar introduced Imaginations, a design competition designed to cultivate the next generation of Imagineers.

Imaginations provides students and recent graduates with the opportunity to display their talents to WDI through a Disney-related project. Teams include two to four college students and/or recent graduates from a wealth of disciplines ranging from fine arts and architecture to engineering and urban planning, among others. A project challenge is provided, and the teams work to produce a concept in a way similar to how Imagineers develop their Blue Sky projects. The 2019 competition, which ran from August 2018 to February 2019, instructed entrants to create an experience that explores a natural or ancient Wonder of the World. The projects could

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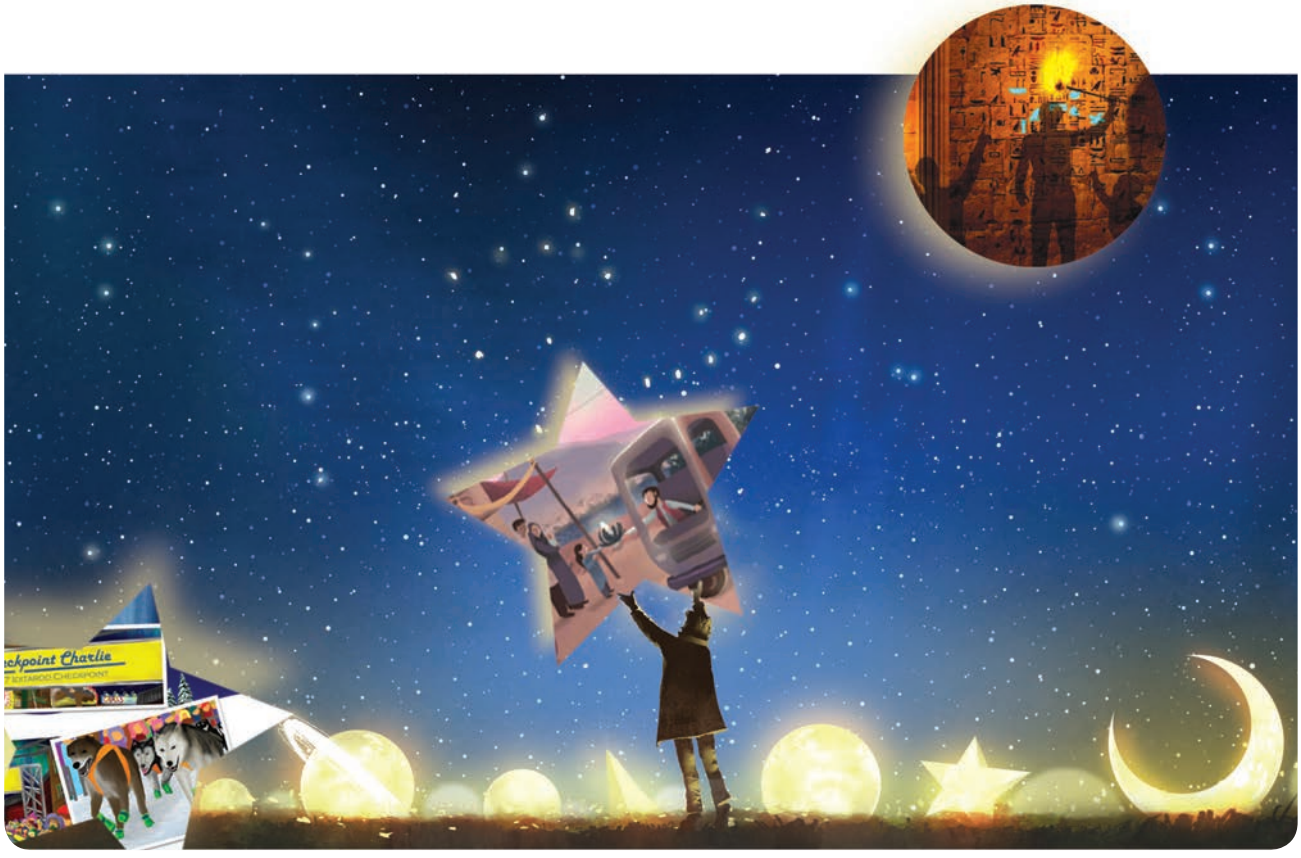

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Coming up Roses

It all began back in August 2018 inside a small coffee shop in Orlando, Florida. That's where we all met up to discuss our ideas for Walt Disney Imagineering's 28th Imaginations design competition before heading back to begin our fall quarter at Savannah College of Art and Design (SCAD) in Georgia. Knowing that this year's project was going to be a challenging one, we discussed ways that themed entertainment can be pushed to become even more immersive and impactful than we've seen it before.

The competition directed students of all skill sets and backgrounds to create an experience that explores a natural or ancient Wonder of the World. The contest proved challenging with a focus on places that are difficult to enjoy either because they are remote, inhospitable, or no longer exist. Students created experiences that explore and share these wonders safely for a wide range of guests, at or near the original presumed location.

From a list of 14 world wonders provided by Disney Imaginations, we quickly decided on The Hanging Gardens of Babylon. Because the original site was rumored to be in modern day Iraq, we designed an attraction on location that would ultimately serve as a means to give back and revitalize the surrounding community and country. The location alone resulted in challenging and extensive research to make sure we could create a feasible and safe experience for everyone as well as tell a compelling story.

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The 2019 Imaginations winners (from left) Zeke Waters, Carolyn Teves, Nicholas Hammond, and Remi Jeffrey-Coker with their project The Rose of Babylon, a botanical inquisitorium for people of all ages.

While working at our summer internship in Orlando, we agreed that our variety of backgrounds and skill sets would be a perfect combination to create a unique project. From our industry experience, we learned that it takes many different skills to be able to tackle such an expansive creative endeavor. Before starting the project, we knew it would take months of research, creative writing, visual development, engineering, architecture, and more to be able to make the cut among so many brilliant students.

Creating a world of wonder

Once we had regrouped back at SCAD in the fall, each of us began figuring out what expertise we could bring to the table to push design limits and create a project that would impress the Imaginations judges. Over the next three months, the team worked together many hours a week alongside our challenging school schedules to compose a compelling competition entry.

As a senior working toward his B.F.A. degree in architecture, Nick assisted with the visual development of the project. He helped to create the concept architecture of the experience and push the elements of feasibility within the project. His goal was to make sure everything would fit and flow together to create a cohesive story.

Zeke, a senior pursuing a B.F.A. degree in production design, prepared the script and presentation that were presented to Imagineering executives in Glendale, California. He also worked diligently to develop the most effective way to communicate the team's concept. On the technical side, Zeke undertook the 3D modeling of the building and helped develop a virtual fly-through of The Rose of Babylon.

Carolyn, a senior completing her B.F.A. degree in production design, took all of our collective ideas and combined them into a cohesive story, which we ended up using for the basis of the project. She also assisted with visual concept development, constructed the physical model of the building structure, and fabricated paper props from the story that were used at the competition finals in California.

Remi, a graduate student pursuing an M.F.A degree in illustration, was the leading illustrator on the project, and it was her job to direct the project visually from beginning to end. From the initial stages where we conceptualized early

not include virtual-, augmented-, or mixed-reality-based solutions and must not contain Disney intellectual property.

"For us, Imaginations is both a competition and an acquisition tool," explains Sariya Singsanong, program specialist at WDI in Glendale, California. "I always tell students that a good opportunity at getting into WDI is through Imaginations. In addition to spending a week here at Imagineering, getting industry insight and mentoring opportunities, there is no better way to literally have your work in front of the key decision makers at Imagineering. You do not need to be a winner to become an intern, and anyone can apply for internships online. [Visit https://jobs.disneycareers.com/professional-internships for more information on Disney careers and internships.] Our finalist teams are the ones that fly out here, so they have the opportunity to participate in interviews during the week, and semifinalists are also included in this pool of people that are considered for internships."

The top six teams in the 2019 competition, comprising 21 finalists, represented a variety of schools including the University of Southern

ideas, all the way to the final presentation, she problem-solved and helped her teammates create the most compelling imagery we could to bring the emotional story of The Rose of Babylon to life.

We ultimately designed the concept for The Rose of Babylon, a one-of-a-kind botanical inquisitorium that offers eclectic entertainment for guests of all ages. The Rose of Babylon is an entertainment venue that invites its visitors to formulate their own adventure based on their curiosity. The overall goal of the experience is to change the world for the better by cultivating a community with our global neighbors.

As guests travel through The Rose of Babylon, they experience activities such as excavating for historical artifacts, a water play lab that illustrates the importance of the Euphrates river, and a vine course that allows visitors to observe the bond between guests from around the world throughout the building. Along with educating the public on environmental, cultural, and social issues, The Rose of Babylon is also designed to help aid in environmental relief for the Euphrates river due to the advanced water filtration systems used in the building.

Our project also highlights a family garden, where guests learn about agriculture and hydroponics. Each family has the ability to plant a new seed in the garden, and the vegetation that is grown is distributed throughout Iraq to communities in need. As more global visitors come to The Rose of Babylon, the gardens will grow in size. We want guests to visit years later and see the difference that they've made. The Rose of Babylon will bloom new life into Iraq, and it provides a notable experience for the country to proudly share with the rest of the world.

Up-close Imagineering

After we discovered that we made it into finals and that we would be traveling to Walt Disney Imagineering headquarters in Glendale, California, we went forward to push the visuals and presentation to new heights. Upon arrival, the fun began with technical runs of the presentation and networking opportunities with Imagineers. It was amazing being able to meet these people that you dream of becoming for such a long time. With initial introductions complete, the second day was spent giving the final presentations in front of a room of judges from various departments of Imagineering.

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The SCAD team collects its first-place prize during the Imaginations Award Luncheon on 8 February 2019.

The rest of the week was filled with visits to different Disney departments, speed interviews, a trip to Disneyland, and bonding with the other six finalist teams. On the last day of the trip, we awaited the results of this year's competition. When they announced our team for first place, we did not expect to win. We accepted the awards with tears of joy and relief, and to add to the surreality of the scene, as we were walking off the stage, we looked up and saw that the visuals of our project had enveloped the entire room. Overall, it was a really magical and rewarding experience.

The Disney Imaginations competition exposed us to many life-changing experiences. All four of us accepted internships with Walt Disney Imagineering and worked together in Orlando, Florida this past summer. Nick, Zeke, and Carolyn graduated in May from SCAD, and Remi will continue her education remotely to earn her degree in the upcoming year.

We attribute our success to a wide variety of ideas and skills, perseverance and support from SCAD, and our Disney Imagineering mentors. We felt prepared going into the competition and that we had done as much as we could to get on stage and present our project in front of Disney executives. We had amazing mentors who prepared us as much as they could for the weeks leading up to the final competition, but we also knew that the other teams' ideas and projects were going to be spectacular.

By Carolyn Teves, Zeke Waters,
Remi Jeffrey-Coker, and Nick Hammond

California, Los Angeles; Olin College of Engineering, Needham, Massachusetts; the University of Texas at Austin; California Polytechnic State University, San Luis Obispo; Savannah College of Art and Design (SCAD), Georgia; and the University of Florida, Gainesville. The first-place team scored a US$1,000 cash prize and an additional US$1,000 grant for its sponsoring university.

First place was awarded to Nick Hammond, Remi Jeffrey-Coker, Carolyn Teves, and Zeke Waters from SCAD for The Rose of Babylon, a botanical inquisitorium for people of all ages. The project is a modern reimagining of the ancient Hanging Gardens of Babylon and serves as a spark to rebuild the nation of Iraq. One of the centerpieces of the experience is the Hanging Gardens, where guests can relax and appreciate agriculture from around the world and actively contribute to the spread of resources and the growth of new life. (See "Coming up Roses" for further details on the SCAD team's project.)

Second place accolades went to Kyle Branch, California Polytechnic State University; Triet Nguyen, University of Southern California; Brooke Pandos, SCAD; and Jessica

Blending Worlds: The Value of Design in Engineering

When we chose to go to a school with "Engineering" in the name (Olin College of Engineering), we never expected that we would be flying out to Disneyland to tour the park with incredible art and architecture students. To be honest, being the only all-engineering team in the finals of the 2019 Disney Imaginations competition made us stick out a little, but our ability to blend the worlds of engineering and design was ultimately the key to our success.

Disney Imaginations is an annual design challenge presented by Walt Disney Imagineering (WDI), where college students from around the world are tasked with a hypothetical challenge about the future of family entertainment experiences and then present their visions through digital art, written text, and, in the finals, a 15-min live presentation. This year's topic challenged us to design an experience built around the location of an ancient or natural Wonder of the World. These designs must address the wonder's unique historical, cultural, economic, and ecological impact on the surrounding communities. We chose to focus on the Northern Lights.

Our project, the Kiiġuyaruq Express, is a five-day train journey through the heart of the snowy Alaskan wilderness.

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Olin College of Engineering third-place winners (from left) MJ McMillen, Eric Miller, and Benjamin Ziemann created The Kiiġuyaruq Express, a five-day Alaskan wintertime train journey.

The Northern Lights have been watching over Alaska ever since humanity first crossed the Bering Land Bridge. The Kiiġuyaruq Express takes visitors on a fantastical journey through the memories of the Northern Lights. At night, guests sleep under the stars in a timelessly elegant glass-topped train. Every day, the train stops in a lovingly recreated town from Alaska's past. Guests experience a 1970s Iditarod sled-dog race, an 1890s gold rush, a 1700s fish bake, and the first human settlements of Alaska. They work with their fellow passengers to solve puzzles through these immersive towns, while learning about Alaskan culture and history. Through the use of a small cell phone-like compass device, guests capture photos and interact with their environment. The photos they take, the people they meet, and the memories they make then culminate in the final day as they are contributed to the Northern Lights, leaving guests with a scrapbook to commemorate their unforgettable adventure.

Like many designers, we were inspired by personal experiences and desires and informed by our expertise as engineers. We have always wanted to see the Northern Lights, but the logistical difficulties of traveling to the far north during the winter make it difficult. The primary Alaskan airport is in Anchorage, in the south of the state, and we wanted to show visitors the far north, above the Arctic Circle. That meant we needed a transportation solution that was spacious, fast, and magical. We chose our favorite form of transportation: a train. As engineers, we were committed to making it as realistically plausible as possible. From figuring out how many rooms can fit in a single train car, how wide hallways need to be for Americans with Disabilities Act compliance, and what power sources work best in the Alaskan wilderness, we left no stone unturned in researching and modeling every last detail. We integrated our technical knowledge of these traditional engineering problems into our presentation.

Once we were selected as one of the top six finalists teams and received the invitation to visit Imagineering headquarters, it rapidly became clear that the Disney Imagineers love this kind

Woody, University of Florida, for Port Pharos. Their work produced a resort formed by fleets of ancient ships traversing waters surrounding a reborn Lighthouse of Alexandria. Port Pharos was designed to honor the history, architecture, and ecosystem that is local to the Lighthouse of Alexandria.

MJ McMillen, Eric Miller, and Benjamin Ziemann from Olin College of Engineering secured third place for The Kiiġuyaruq Express, a five-day wintertime train journey originating in Anchorage, Alaska, and extending north to some of the most secluded regions in the world. Each day, the train stops at the site of a historical event or culture, and guests disembark to experience a recreated vision of the past where they can use a personal compass to act as agents of the Northern Lights, assisting the people they meet with various challenges while collecting memories along the way. (For further details on Olin College of Engineering's project, see "Blending Worlds: The Value of Design in Engineering.")

"The teams that typically shine through are usually the ones that are the most cohesive," Singsanong says. "They are able to pinpoint all of the different talents on their team. We recommend having a really diverse team because it's difficult if you have four graphic designers on the same team, although you can be a graphic designer and have multiple skill sets. The most important thing is to show us what you do best. That mirrors how we work—we don't have entire teams of just graphic designers or engineers. But there are exceptions. This year, the team from Olin College of Engineering was all robotics engineers. It's really interesting to see where all the skill sets shine through even when all of the students are of the same discipline."

of thinking, and it showed, as we ended up placing third. During the event-packed week of the finals competition, we were able to see how WDI approaches its engineering processes by focusing on building experiences for their park guests that tell cohesive narrative stories and inventing the technology needed to bring those stories to life. We experienced everything from how Imagineers develop *Audio-Animatronics* figures to their approach for sculpting huge rock facades and how that comes together into massive and immersive narratives.

Embracing uniqueness

Replicating this approach to storytelling was both the most difficult and most fun part of making our own project: distilling six months of ideation, late-night talks, and details into a short presentation for a diverse audience. A big part of helping guide us in this process were our mentors. In addition to our college professors, we also received guidance in the form of our Disney mentors, Ray Scanlon, Allison Masikip, and Matt Ho, previous finalists who ended up working as full-time Imagineers. Wanting to pass on their knowledge and experience to prospective Imagineers through the Imaginations program, they gave us advice on direction, format, and how to make our presentation memorable. Their help was invaluable. They pushed us to focus on user interactions and embrace what made us unique.

All three of us are undergraduate students at the Olin College of Engineering, where this philosophy is common. Here, our entire curriculum is built around the idea that engineers are most successful when, in addition to the more traditional engineering tasks, they can understand and optimize the entire process of creating a product or experience with users in mind. From this perspective, every engineering task ultimately comes from some human desire, and understanding how human nature connects that desire to the design requirements is as important as understanding how the laws of physics and mathematics relate the design requirements to the final specification. That means that "design" isn't a separate discipline but an integral and inevitable part of the engineering process.

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Sorcerer Mickey presents the third-place award to (from left) Ziemann, McMillen, and Miller.

Although we are all robotics engineers by major, each of us brought our own diverse set of skills and experience to the team, both in the technical and the storytelling sense. Using the tools with which we were comfortable and had experience, we visually told the story of the Kiiğuyaruq Express how we knew it best. All of the digital art was done by MJ, whose love of art and painting helped her to learn and experiment in Photoshop just weeks before the competition due date. Details that were hard to convey in painting were shown through Benjamin's computer-aided design models of the compass and titular Kiiğuyaruq Express. Finally, Eric brought the compass to life in a functioning prototype that was used in a live tech demo during our final presentation.

From learning and researching, presenting our design, and meeting and touring with the other finalists, every step of this experience was a blast. More than anything, though, it further cemented the importance and potential of design in any curriculum and in our futures as engineers.

By Eric Miller, Benjamin Ziemann,
and MJ McMillen

A magical week

Imaginations goes beyond a typical competition and awards ceremony. The weeklong experience allows the finalists to peek behind the curtain and view some of the inner workings of WDI including tours of headquarters and Research and Development as well as other interesting areas of Disney such as Disney Studios and Feature Animation. They also broke off into functional sessions designed to explain the work conducted by the various WDI studios and took time to meet with WDI mentors who were assigned to each group to help guide them through the competition. The teams unwound a bit by spending a day soaking in the sights at both Disneyland and Disney California Adventure Park, where they were able to speak with Imagineers and learn some tricks of the trade.

For many of the finalists, the ultimate prize was scoring one-on-one time with Imagineering hiring managers. Internships can last anywhere from three months to one year and offer the opportunity to walk in the shoes of an Imagineer. "Our interns aren't really interns; they become colleagues from the moment they start here," says Singsanong. "They're going to work side by side with Imagineers every day. Our interns don't go and get people coffee. Some of our interns are Ph.D. students, and others have built robots before they come intern with us, so we're not going to make them go make photocopies and do busy work. There's no real entry-level position for interns; you come in immediately and start doing the job in the department that you are assigned."

The 2019 iteration of Imaginations attracted more than 360 teams and 850 individuals, but the competition is always looking for new blood. Singsanong takes a road trip during the year to pitch the competition to schools that are not familiar with it,

(a)

(b)

Imaginations finalists cut loose with a little leisure time at (a) Disney California Adventure and (b) Disneyland.

The Imaginations finalists gather with Sorcerer Mickey at WDI headquarters in Glendale, California.

Second place in the 2019 Imaginations competition went to (from left) Kyle Branch, Brooke Pandos, Jessica Woody, and Triet Nguyen for Port Pharos.

and the exposure has proven successful, as one of the schools she visited in 2018, the University of Texas at Austin, placed two teams in this year's finals.

"SCAD and MIT are world class in narrow things like art and engineering," adds WDI Program Manager Mk Haley. "Some of the other universities where we get a lot of bang for our buck have great engineering or business management programs, and I can selfishly pick and meet with folks from all of those programs. You also need to have those soft skills on top of your technical and creative abilities. We are very diverse in skill sets that we need to do what we do. The people who really thrive here work well on teams, work well across disciplines, and understand what it takes to do original research on projects and tell a story within your medium."

To all prospective entrants, and particularly those with more of a technical background, Haley offers the following advice: "A lot of the time, students will go on the Imaginations website and see some projects that were really art heavy and think that we are looking for just art-heavy-type projects. If they are very strong technically, they should understand that we really want to see those technical talents. It's called a 'design competition,' so many people's first instinct is to focus on the art. But it's really about focusing on what you do best and showing us those talents."

To learn more about how can get involved in the 2020 Disney Imaginations project challenge, visit www.disneyimaginations.com.

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Earning your ears: The value of internships

Sophia Acevedo

I was born and raised in the San Fernando Valley in Los Angeles, California. From a very young age, I was interested in science, technology, engineering, and mathematics (STEM) fields. I was good at math, and I had a knack for putting things together. In high school, I held leadership positions on my robotics team, and as a college undergraduate student, I majored in physics. I participated in six summer internships at NASA's Jet Propulsion Laboratory working on space technology, with my favorite being midinfrared instrument thermal testing for the James Webb Space Telescope. I then earned my master's degree in mechanical engineering. With this rigorous experience in STEM, I decided to pursue traditional engineering roles.

What I had neglected in that thought process are the other interests and skills that I had developed during my early growth in the STEM fields. In high school, I held a leadership position on the Student Council. As an undergraduate, I also majored in religion. I enjoyed ceramics and cooking and thrived when I was able to work on projects where I could help my teammates formulate strategies for design and execution. It was during a conversation with a mentor that I realized that I had so much more to offer. To have a fruitful career, I needed to foster my STEM side as well as my creative and gregarious nature. I wanted to pursue a career where I worked with teams of engineers in a way that I could help them get to a finish line, be their advocate, and serve as a translator in a world that often does not understand the needs

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As a WDI projects control planner, Acevedo is "the glue" binding the engineering, artistic, and business sides of a project.

PHOTO CREDIT: SOPHIA ACEVEDO

and decisions of high-functioning engineering teams.

Many people have asked me about how I was able to secure an internship at Walt Disney Imagineering (WDI). At the time, I was working toward finishing my master's degree in mechanical engineering from Carnegie Mellon University in Pittsburgh, Pennsylvania. As I neared the end of my education, I thought a lot about what my next step looked like. I realized that I wanted to work for a company that took engineering to the next level, one that was able to do something creative and beautiful with technology.

Like many other students who are reaching the end of their academic program, I attended every networking session, meet and greet, and career fair the university provided in the hope of creating a postgraduation opportunity for myself. When I saw posters advertising the chance to meet with WDI, I knew that I had to attend.

The day of the networking session, I rushed from the job I held at the local Starbucks to campus with my resume in hand and mocha syrup in my hair. Nervous, and wanting to make a good impression, I made my way into the room where a horde of other hopefuls crowded with their portfolios. There were so many people that the recruiters had to meet us in groups of five. My turn came to give my elevator pitch that I practiced in the mirror that morning. I presented my spiel and actually felt good about it. I never ditched class, but this time I skipped to wait for the end of the event so I could meet the recruiters again. (Sorry, heat transfer class!) It was during this encounter that I secured a WDI business card.

A couple of months went by until an opportunity came across the Disney Careers website that interested me. I applied and reached out to my contact from the networking event, and the process was pretty smooth. I accepted an internship position as a project controls specialist for the summer following graduation.

Force perspective

My internship at WDI began in June 2016. Interning with a project-based company, I was eager to find out on which project I was going to be placed. To my excitement, I joined the team that was creating both *Star Wars*-themed lands for Disneyland

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Acevedo's 2016 internship involved joining the team tasked with creating *Star Wars*-themed lands for Disneyland and Disney's Hollywood Studios at Walt Disney World Resort. The first of the two lands, *Star Wars:* Galaxy's Edge in Disneyland, opened on 31 May 2019.

at the Disneyland Resort in Anaheim, California, and Disney's Hollywood Studios at Walt Disney World Resort in Orlando, Florida. I did not grasp the magnitude of the project at the time, but I knew this was going to be big. As a project controls specialist, my primary assignment was to serve as the earned value manager for all facility design efforts. I entered a group in which I had no formal education. I didn't know anything about how to build a building, but I learned quickly. My engineering background taught me how to analyze systems, and that is what I did. I took the system apart and then figured out how to put it back together. Soon enough, my internship was extended from that one summer to a full year. Before my time as an intern was complete, I was converted to a full-time hire.

CRAIG CAUSER

(a)

©GOOGLE MAPS/JOHN GESSING

(b)

(a) WDI offices are located in Glendale, California, but (b) an on-campus sign post shows just how far its work reaches.

What I learned during that internship was how to be resourceful and to ask for help. At WDI, people are always willing to talk about what they do. As a new person to the organization, I asked *a lot* of questions. My job was to help groups formulate plans for executing design, and for me to guide that formulation, I needed to understand what it was we were planning for. Asking questions is a great way to learn about anything.

I also discovered that, in the way that students learn differently, people in a professional organization work differently. In addition to learning about the work itself, I had to understand the engineers themselves—how they work, process information, and communicate. My ability to be empathetic to the human aspect of my job coupled with comprehending the physical work became crucial to becoming a valuable member of the team.

Back in "Black"

It's one thing to have a great internship, it's another to want to stay on permanently. It didn't take long into my time at WDI for me to decide that I wanted to stay. The work was great, and I finally had the chance to work with some of the best engineers making the coolest things for *Star Wars*: Galaxy's Edge.

As I transitioned to a full-time hire, I absorbed more responsibilities. I was involved with the planning of the design, production, and installation of all show elements in Black Spire Outpost for *Star Wars*: Galaxy's Edge. The show group of Black Spire Outpost consisted of teams that created special effects, *Audio-Animatronics* figures, show sets, and props, among others. As the planner for this team, I was able to provide an executable framework for the tremendous work they had to accomplish.

The best part about working for WDI, even more than the amazing experiences we create for our guests (and that's very significant), is the people I work with each day. Imagineering is full of passionate people with unique stories. Every person you meet has an eclectic skill set that he or she brings to the table. Especially motivating were the women on my team working on Black Spire Outpost. Never in my educational and professional experience had I been led by such strong, motivated, and supportive women. At WDI, I feel that my professional and personal growth is being fostered.

Although I am not a traditional engineer, I am still deeply immersed in a STEM environment because STEM is in everything we do at WDI. I get to be the glue between the engineering, artistic, and business sides of all aspects of a project. My science and engineering background helps me to ask more informed questions and provides a different perspective in the constant problem solving that we work through. I wouldn't have pursued a career like this if I had not been honest with myself or had the support to broaden my idea of opportunity.

About the author

Sophia Acevedo earned her B.S. degree in physics from Dickinson College, Carlisle, Pennsylvania, and her M.S. degree in mechanical engineering from Carnegie Mellon University in Pittsburgh, Pennsylvania. She is a projects control planner at Walt Disney Imagineering in Glendale, California.

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Around the world: International parks are distinctly Disney

Craig Causer

The United States is the epicenter of the Disney parks—Disneyland in Anaheim, California, is the original and the heartbeat, while Walt Disney World in Orlando, Florida, is a behemoth that attracts tens of millions of visitors a year. Walt may have spent his formative years in the American Midwest, but his imagination spread to all corners of the world. In addition to the U.S.-based destinations, Hong Kong, Paris, Shanghai, and Tokyo also host a variety of parks that showcase classic attractions as well as park exclusives. These resorts capture the Disney aesthetic, but each presents unique challenges and cultural sensitivities.

Walt Disney Imagineering (WDI) Executive Producer Ali Rubinstein worked on the Shanghai and Hong Kong parks, sites that are both located in East Asia but offer differing cultural perspectives. "It's interesting because, in Shanghai, we went in there and were very respectful of the culture and tried to make design decisions that would be appealing to the local audience," Rubinstein recalls. "We wrote our scripts in Mandarin. Conversely, when we did Hong Kong, originally, we went in with a much different attitude. First of all, it was 10 years before Shanghai. It was the first Disney park in China, and we really wanted to introduce the Disney aesthetic. We didn't copy, but we came

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as close as possible to the original 1955 Anaheim Disneyland as we could in Hong Kong. Also, at the time, Hong Kong was somewhat more westernized. There are more English speakers, and that is slowly evolving and changing. It's becoming much less of an expat community, and there's much more of a local presence."

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Mystic Manor at Hong Kong Disneyland integrates traditional Chinese stories and myths into its plotline, and WDI was careful to ensure that the tales were properly represented so the content would not be perceived as insulting or appropriating.

One of the larger ongoing projects at Hong Kong Disneyland is the transformation of its castle. The reproduction of the Anaheim castle will make way for an iconic structure unique to Hong Kong. This four-year project involves raising the castle to quadruple its current height and adding a nighttime show. The new castle will be joined by another kind of kingdom when Arendelle and the world of *Frozen* arrive in 2021. The land is a full expansion toward the back of the park and will include an inside boat ride attraction and an outdoor roller coaster.

There's a universal understanding of recent global blockbusters, like *Frozen*, that often translates to the attractions that they have inspired. It becomes a little trickier when designing stories based on traditional myths or entirely new stories, as Imagineers consider varying degrees of local cultural sensitivities.

"Cultural appropriation is a sensitive topic right now, both here in America and over there," Rubinstein explains. "There are different types of sensitivities. There's an attraction in Hong Kong called Mystic Manor, and it's basically our haunted house in Hong Kong. In the storyline, we used a couple of traditional Chinese stories and myths, and we had to be very careful and sensitive to make sure we were representing them right and weren't doing anything that would be perceived as insulting or appropriating. We work with people locally, but we also hire historians and professors and go to the universities and seek out academics. We spend a lot of time talking to people and asking questions to make sure everything's okay and that it's going to fly with the audience."

(a) (b) (c)

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Hong Kong has proven to be a hotbed of Marvel action. (a) The popularity of the Iron Man Experience led to more heroic adventures. (b) *Ant-Man* actor Paul Rudd approves of the new Ant-Man and The Wasp: Nano Battle! attraction. (c) (From left) Marvel Studios President Kevin Feige and *Ant-Man and The Wasp* Director Peyton Reed bring up the rear in battling Arnim Zola and his army of Swarm Bots alongside Rudd and actress Jessica Hsuan.

Each park has its own specific needs and interests, and the Hong Kong audience has stated, "Make Mine Marvel." The Iron Man Experience was Disney's first-ever Marvel attraction, and it was unveiled in Hong Kong in 2017. The popularity of the Iron Avenger's ride resulted in the park going small for its next endeavor: Ant-Man and The Wasp: Nano Battle! opened in March 2019.

Imagineers worked closely with *Ant-Man and The Wasp* Director Peyton Reed and the film's stars, Paul Rudd and Evangeline Lilly, to craft an attraction that is both light hearted and action packed, as guests join the heroes' mission to destroy Arnim Zola and his army of Swarm Bots.

"Ant-Man and The Wasp: Nano Battle! is an interactive gaming technology similar to Buzz Lightyear's Space Ranger Spin but much more advanced," says Rubinstein. "We've gone in and redone the gaming interface—there's no more joystick, and the targets are more reactive. We are actually focusing you toward targets. It's a much more enhanced system. For this attraction, we knew the ride system first, so it was a matter of looking for the right story and the right overlay that would work with the attraction we already had. But it does go both ways; other times we'll have the IP [intellectual property] set first and then we're looking for the attraction."

A Magic Kingdom for the mainland

Approximately 760 mi north of Hong Kong, on China's east coast, lies Shanghai Disney Resort, which serves a completely different demographic than its sister park to the south. Approximately 97% of the Shanghai resort's guests are from mainland China, as opposed to Hong Kong, whose visitors are split into thirds between Hong Kong, the mainland, and Southeast Asia, according to Luc Mayrand, portfolio creative executive at WDI. The goal with Shanghai was to answer the question, what is a Magic Kingdom for the mainland?

To address this question, Disney developed the Authentically Disney, Distinctively Chinese program, which provides a series of insights about how Imagineers work and deploy all of their experience of learning from Chinese history and culture, franchise research, working with experts and consultants on location, as well as building its teams. One of the most important things for its teams is to provide the proper perspective.

"I've spent a lot of time working on Shanghai projects and other locations abroad, and it's nice to not have that built-in filter," Mayrand admits. "On the positive side, there's less of a tendency to be attached to things in new markets, but the audience sometimes also doesn't have the same background in movies. They haven't seen movies that our audience [in the United States] would take for granted. It's both an asset and a risk. When there is nostalgia, it can be an obstacle in that you always have to be cautious of the guests and their likes and dislikes. At the same time, I'm a big believer that if you take something out and replace it with something that's better, then the audience will eventually come around, because we are generally working at improving the parks with something really new and different. You can't be cavalier; you have to be really respectful of the guests."

Two of the most popular IPs in Shanghai range from the nostalgic to the new. After it was released in China, *Zootopia* became a US$1 billion box office hit. The story resonated with audiences, and WDI announced earlier this year that work would commence on a *Zootopia*-themed land. The park also bet big on Disney stalwart Pirates of the Caribbean, but the classic boat ride was given a bit of a makeover.

"The original Pirates of the Caribbean rides were very cool and are still classics, but we took our Chinese partners in the project through our parks, and it was very interesting," Mayrand says. "They really liked it, and loved the movies, but because they hadn't grown up with the classic Pirates ride, some of them said, 'That's cool but you know, I'm kind of feeling like I want to be deeper into it.' That's our freedom to change and improve. We also had all the movies, so we had new angles to kind of build a new story, and what we came up with in the end is different than the original."

The Shanghai version, Pirates of the Caribbean: Battle for the Sunken Treasure, is still a boat journey, but the ride vehicle is highly controllable in that it moves both forward and backward thanks to underwater magnetic motors. The narrative is also new, and the attraction received modern projection and *Audio-Animatronics* technologies.

How new projects and refurbishments are handled depends upon their scope. For instance, if it's a matter of updating a restaurant to a different theme, the local Imagineering team will handle the heavy lifting. In the case of a brand-new attraction or land, the work begins by taking pictures and conceptualized ideas in 3D. One of the first evaluations performed is the balloon test, according to Mayrand. When a location has been identified for an attraction and the concept drawings and initial plan are complete, someone on site plots all the outlines of the

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An artist's concept rendering of Shanghai Disney Resort's anticipated *Zootopia*-themed land.

structures and flies balloons up on strings that are the intended height of the buildings. Prior to the park opening, workers take pictures of the balloons from various locations of the park. That information is used to determine sightlines and refine plans accordingly.

"There's a lot of experimentation and discovery that happens, which is what I really like," says Laura West, senior concept designer. West often works on front-end delivery of projects including Blue Sky visioning and the final illustrations. "I sometimes think about feasibility when I'm drawing, but many times I just think outside of that because I know the people here are so imaginative in a technical way—beyond what I can even conceive. If I can think of it and draw it, a lot of times they can figure out a way to make it work."

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Shanghai's Pirates of the Caribbean: Battle for the Sunken Treasure is a boat journey just like the Disneyland classic, but it differs in that the ride vehicle is highly controllable and travels both forward and backward.

These various projects happen at different time frames and among the backdrop of a bustle of ongoing activity. Like many Disney parks, Shanghai is consistently dressed for various special events, including Halloween and Chinese New Year. Add in annual celebrations, updates to shows that are currently running, ever-changing food programs and retail

(a)

(b)

(c)

(d)

IMAGES—©DISNEY

Two major ongoing expansions are currently taking place in Tokyo's parks. (a) *Beauty and the Beast* and (b) *Big Hero 6* attractions are slated for Tokyo Disneyland. The (c) Tokyo DisneySea development focuses on the addition of an eighth port, which will include (d) the kingdom of Arendelle from *Frozen*. (All images are artist concept renderings.)

©DISNEY

How do you stand out in a country that boasts historic castles? By creating a stylized version of Sleeping Beauty Castle for Disneyland Paris.

locations, and deploying or developing campaigns around characters, and it seems like a never-ending evolution.

"If you talk to an Imagineer, we want to build everything everywhere," Mayrand says. "We have ideas for everything. But there's only so much time and so much money, so we plan out how we're going to do things. There's a lot of great stuff that's happening both internationally and in the U.S. right now. All these things around Marvel, *Star Wars*, and *Frozen*—it's just crazy."

By land and by DisneySea

Tokyo Disney Resort represents two parks, several Disney-branded hotels, a monorail, and an area that houses other hotels and shopping experiences. It follows the blueprint set by the other resorts but with one caveat—Disney does not own or operate the property. It's owned by Oriental Land Company (OLC), a Japanese corporation that was formed in 1960. Disney signed an agreement with OLC in 1979 and then, in 1983, the first international park was built. It's not a joint venture; Disney does not invest in the resort financially (although it does receive a percentage of the revenue), but it is Disney's IP and name on the property. Anything that goes into Tokyo Disney Resort must be approved by Disney.

"We rely heavily on OLC to guide us with localization and what content will resonate with the Tokyo guest," explains Daniel Jue, portfolio creative executive. (Each of Disney's resort locations is referred to as a portfolio.) "But we also do our own research. There is a branch of Disney in Tokyo as well, and we heavily utilize them as a resource to guide us as far as what works and what doesn't work and how to adapt our content for the resort in Tokyo. When we are master planning, a lot of times we will develop, with our own understanding of what resonates in Japan, a product. Sometimes we will develop several ideas early on and then review those with OLC to see which ones resonate the most. Approximately 70% of the guests that go to Tokyo Disney Resort are female, with a very high affinity for Disney, and they are character driven. What's interesting is that the number one entry point for the Disney brand is the Japanese resort rather than movies or television or anything else. When people think of Disney in Japan, they think of Tokyo Disney Resort."

The original park was a combination of Magic Kingdom in Florida and Disneyland in California. OLC wanted a western park that was authentically Disney. When you walk through the resort, all of the marquees are in English, and it may not initially seem that you are in Japan. The park boasts rides including Big Thunder Mountain, Space Mountain, Splash Mountain, and "it's a small world" that are all high-performing favorites. There are also unique attractions: Journey to the Center of the Earth; Pooh's Hunny Hunt, which was Disney's first trackless ride vehicle in any park; and all of Tokyo DisneySea is a completely unique theme and story.

Two major expansion projects plus a Soarin' attraction are currently on the docket. The first is the largest expansion of Tokyo Disneyland since its opening in 1983. It includes a brand-new *Beauty and the Beast* e-ticket ride, which is the first attraction based on the 1991 animated film in any Disney park. Jue describes it as "a technological marvel that uses free-ranging vehicles to tell the story of when Belle first enters the Beast's castle, meets the enchanted objects, and eventually falls in love with the Beast." Adjacent to that area will be a new indoor 1,500-seat, Broadway-style theater with a balcony, loft, and pit, the first indoor theater at Tokyo Disneyland. The Tomorrowland area will add a Baymax attraction, and Toontown introduces a new Minnie Mouse character encounter. The Tokyo Disneyland expansion is scheduled to open in 2020.

The second expansion, which is approximately 22 acres, focuses on Tokyo DisneySea. Whereas Tokyo Disneyland has lands, Tokyo DisneySea contains seven ports of call, with an eighth to be added. The new port is going to have four areas, one of which serves as the connective tissue of the entire land—a magical spring that is able to travel to different stories. The three stories that Tokyo DisneySea will tell are Neverland, with Peter Pan and Tinker Bell attractions; Rapunzel, where you can experience the Lantern Festival from *Tangled;* and Arendelle from *Frozen* (which will differ from Hong Kong's upcoming *Frozen* offerings), with the ice palace and Arendelle Castle.

Tokyo DisneySea took to the friendly skies when Soaring: Fantastic

Flight opened earlier this year. The project proved to be a challenge since it was housed in the park's Mediterranean Harbor, which is an Italian setting from the 1800–1900 timeline but the film features modern-day airplanes and architecture.

"We created an extra backstory to bring us to that place in time," says Danielle Lieu, producer. "We have a new character named Camellia Falco, she's a member of the S.E.A. [the Society of Explorers and Adventurers], and that is a story unique to Tokyo. She really resonates with our fans and makes them feel like the park is theirs, and they want to learn more about these characters that are unique to Tokyo DisneySea. Soarin' in Tokyo is a different attraction. It's still an experience where your feet are leaving the ground but getting to that experience, you queue through the Museum of Fantastic Flight—all of these displays and artwork that talk about our imagination about flight back before planes were invented. That's the queue area. We have a preshow where you meet Camellia Falco, and her spirit comes to life as she talks to you about her passion for flying. That leads you to the theater where you take off."

For Lieu, working on an international property allows her to constantly build upon her knowledge base and acquire new skills and responsibilities. She came to WDI as an intern who was studying architecture. Once she arrived on the Glendale, California, campus, she was tasked with design support for creative—sketches or model building—anything that was used to help explain an idea. Lieu returned after graduation and was ultimately hired by Jue to work on the Tokyo Disney Resort portfolio. She helped with whatever they needed, such as taking notes and making graphics, but has progressed to learning how to lead her own teams.

"Each time I join a project, I'm working on something I haven't done before," Lieu explains. "First it was a project dealing with interior design and a few special effects, and now I'm learning about new ride systems and the process of creating animated figures. I'm constantly building on a base that I started with but knowing that I will always continually learn because no project is ever the same. And that's the exciting thing about working here. It keeps it interesting."

A Valentine to the French

Visitors by the millions flock to Disney parks each year, and throngs of people make a beeline for the majestic castles that welcome guests to a world of Disney attractions. The castles of Cinderella and Sleeping Beauty are inspiring to millions of Disney guests around the world, but when you're a country like France that is steeped in history, how do you "out-castle" Chenonceau and Chambord in the Loire Valley? The answer for Disneyland Paris was to flip the script and opt for stylization over realism.

According to Tom Fitzgerald, creative executive, Imagineers Tom Morris and Tony Baxter focused on artist Eyvind Earle's designs from *Sleeping Beauty* that were super stylized. With Le Château de la Belle au Bois Dormant, the duo pushed

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There is only one Disney castle that can boast of having a dragon living beneath it, and it's located in Paris.

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The Iron Avenger takes to the skies in Hong Kong Disneyland's Iron Man Experience.

WIKIMEDIA COMMONS/WILLIAM WARBY

In 2017, Disneyland's Space Mountain received a *Star Wars* makeover and became Hyperspace Mountain but the Georges Méliès cannon (right) remained.

the fantasy aspect of the castle to include a swooping landmass and box-shaped trees. To engage further fantasy elements, a dragon was added in the basement—the only Disney castle to feature such a creature. The fantasy aspect was accentuated because Imagineers knew if they didn't go in a distinctly different direction, the structure would seem underwhelming to an audience that grew up in the vicinity of some of the world's most beautiful castles.

While the architecture in France is consistently beautiful, the weather is a different story. Dealing with Parisian weather patterns presents more than a few design dilemmas. Weather plays an important role and in ways of which you wouldn't normally think, Fitzgerald notes. What color do you paint the castle? What's the color of light? Since the light in Paris is different than the color of light in Florida or California, colors need to be adjusted to account for the gray skies of Paris.

"Weather is definitely going to affect the materials you choose," Fitzgerald adds. "You're going to have freezing and water, and that's going to get into cracks and break things. We use less concrete in our walkways and more stone pavers. When you go to Europe, you see stone pavers everywhere because they don't crack, they look beautiful, and they're easy to swap out if you need to change them out. Those are some of the things we've learned over time. Plus, beautiful stone is very available in Europe."

Fitzgerald equates the maintenance of the parks to painting the Golden Gate Bridge—the work is constant. Every year, there are hundreds of items that need to be addressed from refurbishments and replacements to entirely new looks. For example, when rehab was scheduled for the scrollwork on the sides of the walkway that lead up to the castle, it turned out that it was going to be more cost-effective to bring in stone carvers from Europe to perform the work. Disney has learned to capitalize on the Paris location, one where old-world craftmanship still exists. Using local craftspeople reduces the need to import and train such workers.

In every one of its resorts around the world, Disney has Imagineering offices. When projects are underway, WDI works to find a balance between which services need to be brought over from the United States and which can be sourced locally.

"In most places in the world, certainly in Europe, where you have the U.K., France, Spain, and Italy, you have a lot of motion-picture-trained people; so, it's not hard to find sculptors or the kinds of trades that we use," Fitzgerald explains. "There are some specialty things that you have to train like rock work carving. Who does that? Mountains are real everywhere else, but we make them. When you say, 'I want to build a mountain,' there aren't many people who do that. We do it all the time, but it's a specialty trade. A lot of those people fall in love with what we do and then they end up asking if they can sign on and stay with us. One of our goals, as we go into the future, is to determine how we get each of these sites to be able to take on more of the Imagineering themselves and then what do we keep for the home office."

As with the other international parks, local culture plays heavily into Disneyland Paris' design. For its version of Tomorrowland, the designer, Tim Delaney, decided to tip his cap to visionaries H.G. Wells and Jules Verne, both of whom made significant contributions to science fiction. As a result, the version of Tomorrowland in Paris is called Discoveryland, and it's based thematically on the works of Wells and Verne. In the land, Space Mountain is the Baltimore Gun Club cannon from the Georges Méliès-directed film, *A Trip to the Moon*, and the attraction is a launched coaster, a first in the Space Mountain series. (While Paris' version of Space Mountain was transformed into the *Star Wars*-themed Hyperspace Mountain in 2017, the Méliès cannon remained.) Each of these nods, according to Fitzgerald, was the result of getting in touch with what resonates locally and paying homage to the French, who had contributed so much to people's dreams of the future.

Consistency across cultures

The traditions, styles, and sensibilities of guests visiting Disney parks in Paris, Tokyo, Shanghai, and Hong Kong are incredibly diverse, but the underlying Imagineering element is consistency, according to Mayrand. "Every office in every park will develop their own culture, which is good, but our job is not just to have these separate cultures with them operating in parallel; we want to have one Imagineering creative culture of how we build things inside Disney."

About the author

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STARS: ©ISTOCKPHOTO.COM/OLEGBACK

"One thing you hear across the board in Imagineering is 'We worked on that' and 'It's our project.' Everything here is huge collaborative teams with technical and nontechnical work. The soft skills are just as important as the technical skills because everything is done working hand in hand, and you need that type of capability to positively and optimistically negotiate scope. The Creative group is going to ask for the impossible, and you work with them to ground [the idea] in reality. You meet in the middle, and hopefully, it results in something everyone is excited about."

—Dave Crawford
Executive, Ride Mechanical Engineering
Walt Disney Imagineering

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What is electrical engineering?

by Elisa H. Barney Smith

As a professor of electrical engineering, I'm often asked, "What is electrical engineering?" My goal is to describe our field to prospective students, both those who are looking at admission in the coming year as well as younger students who may be a decade away from college. According to *Wikipedia*, "Electrical engineering is a technical discipline concerned with the study, design and application of equipment, devices and systems which use electricity, electronics, and electromagnetism. … Electrical engineering is now divided into a wide range of fields including computer engineering, power engineering, telecommunications, radio-frequency engineering, signal processing, instrumentation, and electronics." Does that cover all of it? In my TEDx talk, one of my opening lines was "Hi, I'm Elisa. I'm an electrical engineer and computer scientist… Most people, when they think of electrical engineering, think of circuits, power grids, radios, and, in Boise, Idaho, perhaps printers and memory chips. Well, electrical engineering is quite a bit more." The talk is on digital humanities, using computing to advance studies in the humanities. Most people don't know electrical engineers can work directly with the humanities. Even when you look at more traditional electrical engineering fields, such as what's taught at universities and the types of jobs many bachelor's degree students accept upon graduation, there's still quite a bit more.

When the American Institute of Electrical Engineers (AIEE), the predecessor of the IEEE, was founded in 1884, its originators included people such as Thomas Edison and Nikola Tesla. They were thinking about electrical engineering as electric power, lighting, and the telegraph. Electrical engineering, and the IEEE today, encompass quite a bit more. In the IEEE, we have 39 Societies spanning many different fields of interest. While we are the *Institute of Electrical and Electronics Engineers*, the acronym *IEEE* is used more often, not just because it is short but also to increase the connection of our professional association with our broad membership. The IEEE's objectives are the "educational and technical advancement of electrical and electronic engineering, telecommunications, computer engineering and allied disciplines." Consider the IEEE Engineering in Medicine and Biology Society, IEEE Geoscience and Remote Sensing Society, IEEE Intelligent Transportation Systems Society, and IEEE Society on Social Implications of Technology to see how broad the field and IEEE have become.

We have many members who are not electrical engineers. While electrical engineers are the majority, there are many computer scientists as well as mechanical engineers, industrial engineers, and quite a bit more in other fields. Our tagline is "Advancing Technology for the Benefit of Humanity." We have expanded way beyond what Edison and Tesla could ever imagine. Does your Student Branch reach out to students in the allied fields for membership? The Student Branch at my university had a business major (who was also interested in engineering) as an officer recently.

What engineering is today likely is not what it will be when you reach the middle of your career. This issue of *IEEE Potentials* focuses on Walt Disney Imagineering. Imagineering is certainly beyond what Edison and Tesla envisioned (Walt Disney was born in 1901, after AIEE was formed). How can you prepare for a career in a field that has not yet been invented? The answers sound very boring: get a solid foundation, and then keep reading and learning. Join some IEEE Societies. The publications produced by the IEEE give you the opportunity to stay up to date with the new things coming in our fields. When you read an article, ask yourself: what other things could possibly follow or be based on them? (Even if you don't fully understand how the technology in the article works.) Can you be your own type of Imagineer? We are counting on you to imagine the future of electrical engineering and the IEEE.

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To learn more*, visit IEEEinsurance.com/HERO

*For information on plan features, costs, eligibility, renewability, limitations and exclusions

The Group Term Life Insurance Plan is available only for residents of the U.S. (except territories), Puerto Rico and Canada (except Quebec). This plan is underwritten by New York Life Insurance Company, 51 Madison Ave., New York, NY 10010 on Policy Form GMR. This plan is administered by Mercer Health & Benefits Administration LLC. This coverage is available to residents of Canada (except Quebec). Mercer (Canada) Limited, represented by its employees Nicole Swift, Pauline Tremblay and Suzanne Dominico, acts as broker with respect to residents of Canada.

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