WORLDBUILDING
MAGAZINE

Fantastic Technology
Incorporating Technology into Your Fantasy World
— *by Tina Hunter*

Reaching for the Stars
Designing Spacecraft for Hard Science Fiction
— *by B.K. Bass*

World Showcase
Joshua Jenkins' *The Hand Unseen*
— *interviewed by Adam Bassett*

Technology

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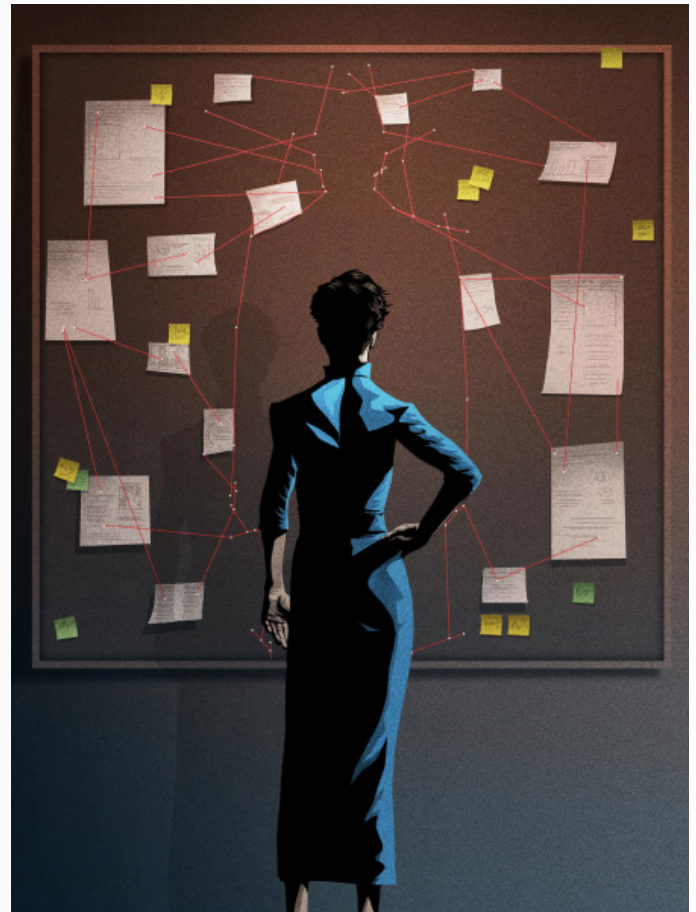
Prompts • Stories • Theory

CONTENTS

SHOWCASE INTERVIEW:
JOSHUA JENKINS' THE HAND UNSEEN

Interview by Adam Bassett

Joshua Jenkins is reimagining our world. He's telling a story that begins in 2014 where United States politics take a decidedly different turn, escalating over an alternate timeline. He is chronicling it on his website through breaking news stories and infographics. We got a chance to talk with him about his view of corporations and his process of writing news snippets and press releases. This is how he describes it.[1]

Joshua: *Hand Unseen* began about 7–8 years ago. I had this idea for a graphic novel that takes place about 100 years from now in a corporatocracy[2]. There were seven corporations running the Americas. Something happened where they couldn't directly mess with each other, so they had to hire freelancers to spy and hack and mess with each other. Kind of a loophole in the system.

Since creating the initial timeline, intended for my own reference, it's gotten much bigger than expected. As I dove into more research, I became obsessed with the worldbuilding. Since then, it has become a timeline of the next 100 years told through journalism and design. It's a bridge between our real world and my fictional corporatocracy. I've spent the past seven years or so working on it, building the timeline, doing all the design and layout, and commissioning all the illustrations. Now I'm fleshing it all out with journalistic stories and infographics. It's a weird way to tell a story, but it occured to me about five years ago it's how we're viewing history in real time. If something happens, I see it on social media. Then I read a few articles (maybe just the headlines), watch something about

Matt Griffin

it on YouTube, and then dump the info because something else is happening. I wanted to tell a story in that style.

And then the question becomes: who curates history now? Depending on who you ask and how they were getting their news, American politics in 2018 can be seen in many different ways. Similarly, there is a meta story going on within *Hand Unseen*. Who is curating the story? Who is picking these

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[1] Portions of this interview discuss real-world events as inspiration for the world of The Hand Unseen. The views represented by the creator do not necessarily represent the views of Worldbuilding Magazine, but were important to include due to how they directly influenced this alternate setting.

2 Corporatocracy: a society or system that is governed or controlled by corporations.

articles to tell this story? Hence the title: *Hand Unseen.*

What brought you to discuss these topics?

A couple of things. I do bomb disposal for a living. I'm a civilian, I've always been pretty left leaning, and I went to work in a field where about 99% of the people didn't agree with me politically. The first two years was brutal. Then I started listening more, and I began to understand where they were coming from; I didn't agree per se, but I started to listen. The big thing with all the guys I work with is more privatization and less government. I wanted to create a world where the government was overthrown by a corporation and what that would really look like. To try to take that seriously—for better or worse.

I was also in Ukraine when it collapsed. It was terrifying. Americans tend to romanticize revolution, and I did a little as well. There's nothing romantic about it, though. It's slow, uncertain, and scary. While I was there, I thought if this were in America, it would be way worse. People are not prepared for this. Even the people that are prepared are not prepared.

Finally, I've noticed a fairly recent change in how corporations function. I see them as a highly pervasive new power structure in the hierarchy, not unlike government or the church. They control our economy, which is the lifeblood of our system, just like the church used faith as its currency. In addition, corporations and government are becoming more deeply intertwined. Citizens United—which grants the right to freedom of speech and religion to corporations—is a big step in that intermeshing. Corporations used the 14th amendment to give "personhood" to corporations, just as it originally gave the same rights to slaves.

That is amazing and completely messed up. But, that is what really got me thinking about what a country run by a corporation would look like.

Has any portion of this project—a particular news snippet or infographic, perhaps—been particularly challenging?

All of it. I'm not a journalist, and I don't know why I thought I could write as one when I started. However, I hired an editor (Nathan Hurst) who *is* a journalist.

So here's how it goes. I come up with an idea about something like, such as YouTube culture in the future, or the history of a corporation. I do a ton of research, and I write a really long entry about what this is and what I want to say about it. Then, I write a "vomit draft" that is often terrible, usually embarrassingly bad. Nathan checks it, trying hard *not* to hurt my feelings but fails miserably. Then I come back with another draft, and he compliments me if it's good. And I get ridiculously happy. He helps a lot.

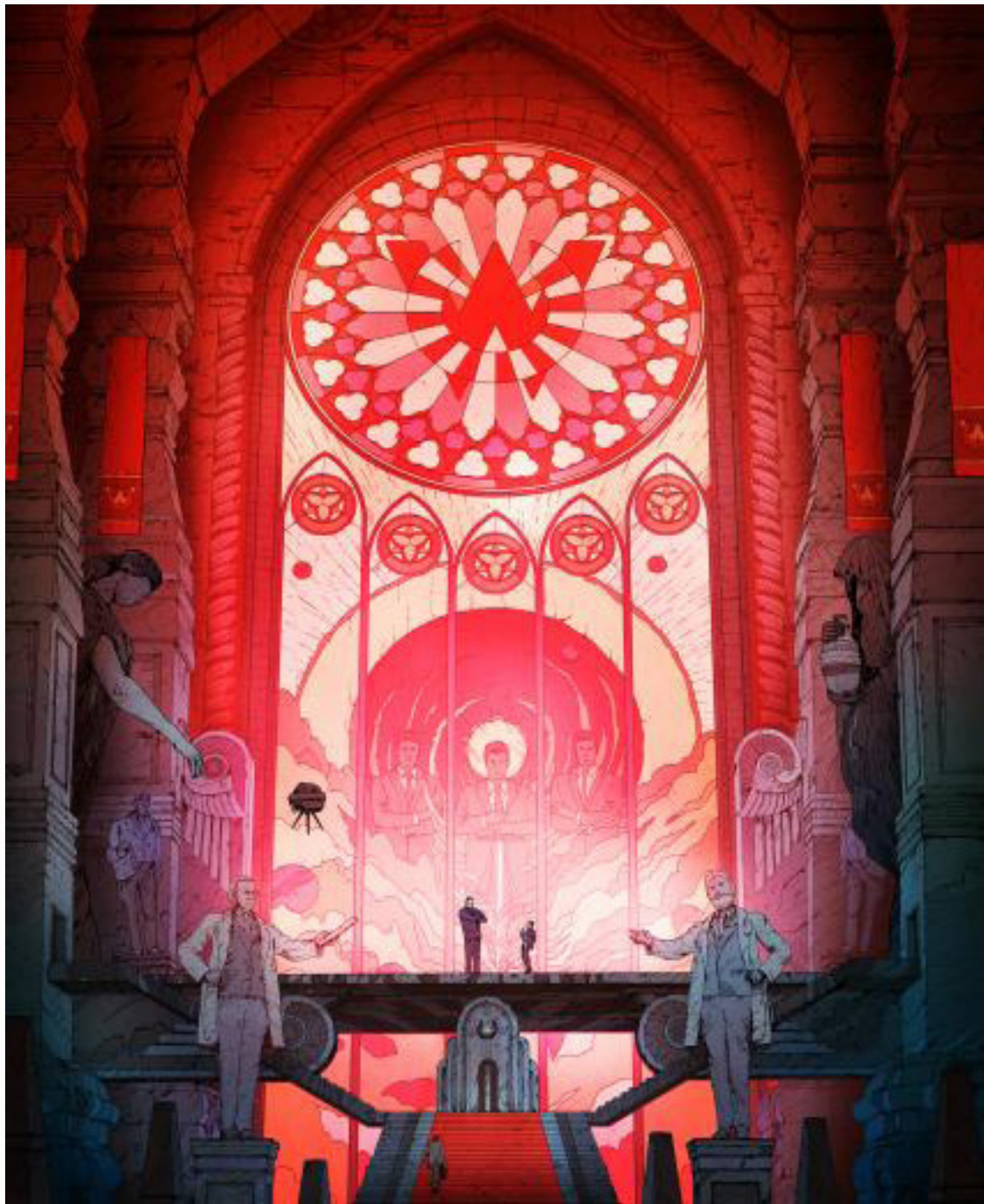I love research. I love conception. I love design. Writing the stories are difficult.

I imagine you must have quite a bit of work behind the scenes which may never appear in this story-timeline of The Hand Unseen, then.

Oh, yeah. I have so much beautiful concept art that nobody has ever seen. *The Hand Unseen* really is a world that I want to work in forever. I'm just laying down all the foundation in a weird, interesting way. When that's done, I can write books, comics, radio theater, whatever. The foundation will be very strong.

The Hand Unseen begins in 2014 with leaked NSA documents. Now that it's April 2019 I'm sure you look at the timeline you've created and are able to draw conclusions about things which are eerily similar, or horribly wrong.

I got a frightening amount of things right, though not in the way I expected. For example, because I do see it as inevitable, I spent a very long time conceiving how America would realistically start down the path of the corporatocracy….

Then, out of nowhere, a CEO becomes president of the United States of America and hires several of his CEO buddies to take on government jobs. Sometimes reality feels like lazy writing. Before Trump began using this slogan, I used "make America great again" for the Commonwealth. I wish I could prove this better, but I chose it because of

Guy Warley

President Ronald Reagan's original slogan "let's make America great again."

However, I also was certain we would be in a strong economic downturn by now. Also, in an effort to show this was in fact an alternate timeline, I made Hillary Clinton win the 2016 election.

How did that impact the timeline?

It didn't, mostly. I don't think who wins elections matters much on a local level. I wanted to show the political system fading into the background. What matters most are jobs, the economy, and the flow of money. Everything else is just entertainment. People will sign over almost anything for the opportunity to provide for themselves and their family.

How are we utilizing technology in The Hand Unseen?

People (currently) are afraid of government control, but I think there's something else far more sinister coming down the pipe. The threat is always us, by which I mean the populace. We are recording

LAW ENFORCEMENT
1.5 BILLION

FOOD PRODUCTION
500 MILLION

INCARCERATION
1 BILLION

GEORGIA BUDGET
C 22.5 BILLION

EDUCATION
12.5 BILLION

INFRASTRUCTURE
3 BILLION

HEALTHCARE
4 BILLION

GEORGIA 2018 BUDGET
C22.5 BILLION
12.5 BILLION 4 BILLION 3 BILLION
1 BILLION 1.5 BILLION 500 MILLION

GEORGIA BUDGET FUNDING STATUS
LAW ENFORCEMENT FOOD PRODUCTION
EDUCATION INFRASTRUCTURE
HEALTHCARE INCARCERATION

PERSONAL TAX ALLOCATIONS
+3%
4% 4% 2%
2% 1% 2%

Joshua Jenkins

and tracking ourselves constantly. We're telling on each other. It's our addiction to social media that's creating problems, so I think the inevitable threat to America is augmented reality.

We all think what we see is the truth, that the world through our eyes is the real one, but it isn't. We're all seeing the world differently. We choose what we want to see and hear what we want to hear. We're slowly realizing that fact, and it's making us all very angry at each other for not seeing the world the way we see it. Technology will always come in to help us with our perceived problems. Hence, augmented reality. It will give us the ability to shape our own worlds. If we want everyone naked, so be it. If we only want pretty people, or white people, or black people, or whatever the case may be, we can do that. These advancements will allow us to change our reality instead of forcing ourselves to adapt to or accept reality. We will think it is for the best, but I

think it will take away what makes humanity strong: the ability to adapt and overcome. Augmented reality will make us weaker as a species.

Has technology advanced in this alternate timeline?

We stagnate. That's another thing I didn't anticipate. Innovation in our [actual] world has not increased on the level I thought it would, at all. After all, the first iphone came out in 2007, the internet was brought online in 1983. It was a quantum leap from any other phone in existence. What else has been a leap that large since then? I find that many advancements have been conveniences rather than innovation.

The other thing that I love doing in the *Hand Unseen* is the technocratic side. I love researching social engineering. Every chapter has a theme, and once I figure out that theme, I see how we're doing it wrong and how it could be better with technology. Chapter 03 (the most boring by far) is mostly about integrating technology into the economy.

That chapter brings up Governance 2.0. Could you go into some detail on what that means?

It's altering our democratic system and changing it out to a corporate hierarchy structure. Citizens become labelled shareholders, senators become CEOs, and treasurers become CFOs. Basically saying you own stock in your city, in your neighborhood. You have invested. What do you want for your investment? The app I made (as a graphic for the site) shows how much you contribute monetarily. And, like a mutual fund, you can move money into a sector that you think needs it. For example, if you have a crime problem you can move your tax money into security. The guys I work with hate the government and think it's useless. Their biggest problem seems mainly to be a perception of mismanagement of their tax money. So, the tech allows them some control over their money.

Chapter 04 contains an origin of the group "The Hand Unseen," who are a bunch of analysts that predict and shape the culture of the country as

[3] *Commonwealth: The commonwealth is a mega-corporation composed for 40 major American corporations that come together to compete and eventually replace the US government*

THE ENGINEER — MAINTAINS THE SYSTEM
THE MATHEMATICIAN — CALCULATES THE PRINCIPLE
THE ARCHITECT — BUILDS THE FOUNDATION
THE COMPOSER — GUIDES THE FACTION
THE DANCER — SWAYS THE INDIVIDUAL
THE HISTORIAN — DETERMINES THE NARRATIVE

THE HAND UNSEEN

Joshua Jenkins

it goes forward. Scientists, politicians, doctors, CEOs—all the people that you think are the most powerful, they all kneel at the altar of narrative. It isn't enough to have a country just be doing well economically. A country needs a unifying story. In a nutshell: our current narrative is democracy, capitalism, and Judeo-Christianism. Essentially, democracy says everyone has a voice, capitalism says everyone has an economic chance, and

Hans Hanzo Steinbach

Judeo-Christianism says there's justice for everyone eventually. Well, we all have phones now and we've seen how all these narratives fall apart when you look at them closely. We don't all have a voice, some of us have no chance, and justice is kind of ridiculous. So in 2023, America is a technocratic corporatocracy. We need a new unifying story, a new narrative.

Is there any part of the current timeline that you're particularly happy with?

I'm pretty proud of all of my social engineering design work, honestly. I think there is some clever stuff there, the "Commonwealth leadership structure" in Chapter 02 especially. It was a weird idea of how to create a corporation with 40 CEOs. How do you put Dick Cheney and Elon Musk in the same room and get them to agree on things? They're completely different people, but they're both CEOs, so how does that work? It was fun to engineer that in my mind.

I'm also excited to get into the more fantastical things that happen along the timeline. We're still pretty grounded in modern day. Once we pass the first volume (which will conclude with Chapter 06), it starts getting out there. I wanted to start off in our world and then slowly move into my sci-fi world. I can't say specifically, but I'm really big fan of *Akira* (manga by Katsuhiro Otomo, who also directed the 1988 film).

What other works do you think influence your work?

Here's what I did, and I think it's really important to do for anyone delving into worldbuilding. First I decided I was going to build a world in which I could tell any story I wanted to, so I never had to leave. I spent a week or so thinking up everything that I love. I mean everything; every video game, toy, political conversation—everything. I wrote down a huge list. Then I went through everything, and I figured out what about that thing made me love it. It could be a color scheme, plot, a villian, or just a single conversation. We all have media that we love for some reason that we never really think about.

As I found the commonalities among those lists, I really got to the bottom of what I loved about storytelling. What I love in a great hero, a great villain, a plot, a conversation. And then I built a world around all of those things. The commonality I found in *Dune*, *Akira*, the works of Alan Moore, *East of West*, *Bioshock*, *The Coen Brothers*, and *Three-Body Problem* is great worldbuilding. They are creators that have a solid foundation, and it makes you invest in their stories because you can feel something behind all their work. The characters feel like they've lived full lives. The rules of the world are solid and easy to understand. The storytelling is tight.

Hence why you're laying such extensive groundwork before writing any stories or making those graphic novels.

That's what I'm doing right now. I'm building my foundation (in a weird way). This is my bible. I'm enjoying the process of building it, and I'm not too worried about people understanding it. However, when I do sit down to write the stories, this project is going to be really neat to have as a backdrop.
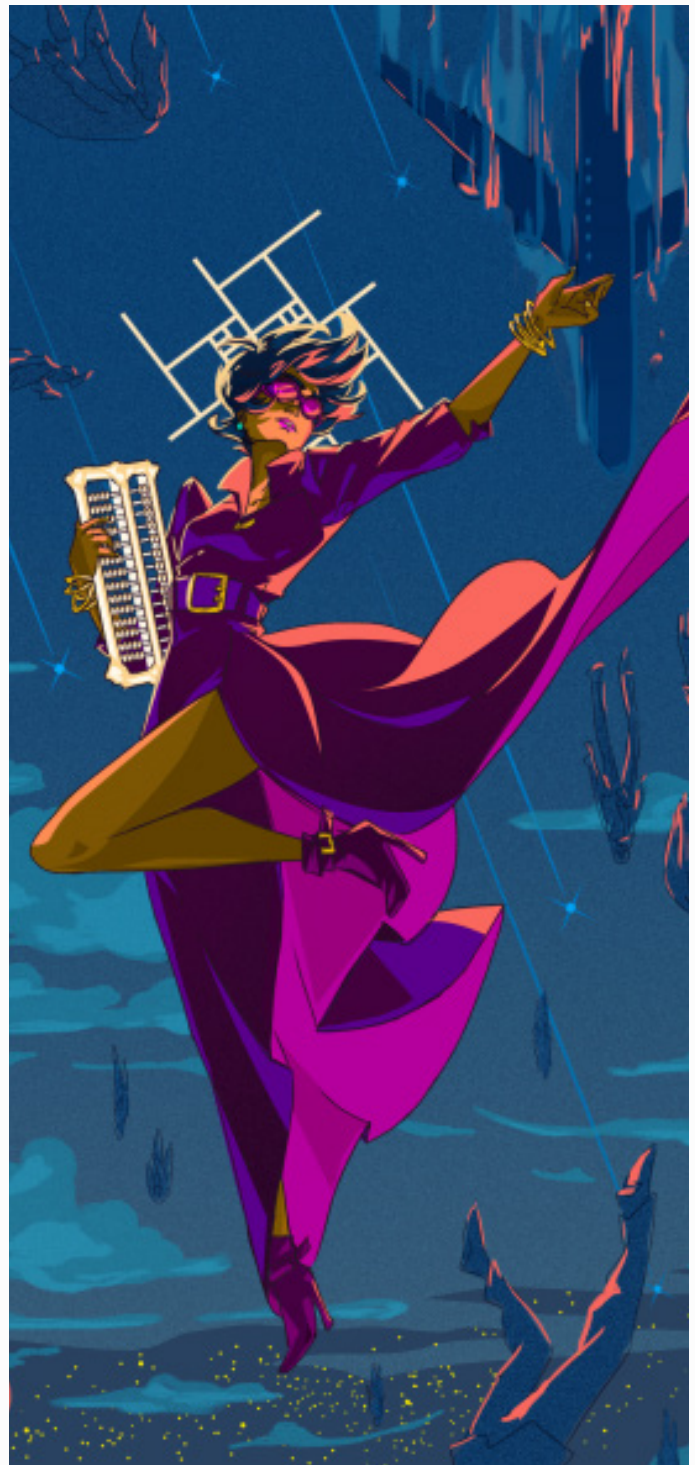
Before we go, what details can you give us about a project you would like to tackle once the world is fully built?

100 years from now, the last remaining corporations have chopped up the Americas into city-states. They've all agreed not to directly interfere with each other, so they use freelancers to undermine each other instead. A new mutation is found in humans, and all the corporations are figuring out how to best commodify it. It's *Game of Thrones* but with corporations. 🪐

This interview has been edited for Worldbuilding Magazine.

Thanks to Joshua for coming by to speak with us for this interview! If you're interested to read more of his work, you can scroll through more of The Hand Unseen on his [website]*. Joshua's also on* [Twitter] *and* [Instagram]*.*

If you would like to be a Showcase interviewee, [click here to apply]*!*

Jap Mikel

GRAPHY

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TECHNOLOGY

THEORY & ANALYSIS

BY CATHY, THE OVERPREPARED
GM, PSYCHOJULIET,
JAREN J. PETTY,
& CRYSSALIA NOIRE

ART BY DEIFICAT

PUNK

The mid-seventies saw the birth of a new artform, punk. It was a style, an ideology, and a way of life. It was a reaction to the peaceful acceptance of the hippie culture, the bombastic glamour of disco, and the calculated, slick production of corporate rock. It was aggressively rude and unapologetically raw. Punk wove together the pared down simplicity of the beat poets, the distrust of institutions from sci-fi dystopias, the revolutionary zeal of the Marxists, and the throw-yourself-at-it ethos of the garage rock scene into a chaotic cocktail of anarchy, nihilism, honesty, and creative expression. Although the word punk started as an insult by an older generation, the new punks revelled in the epithet, owning their image as troublemakers and unwilling to gloss over ugliness.
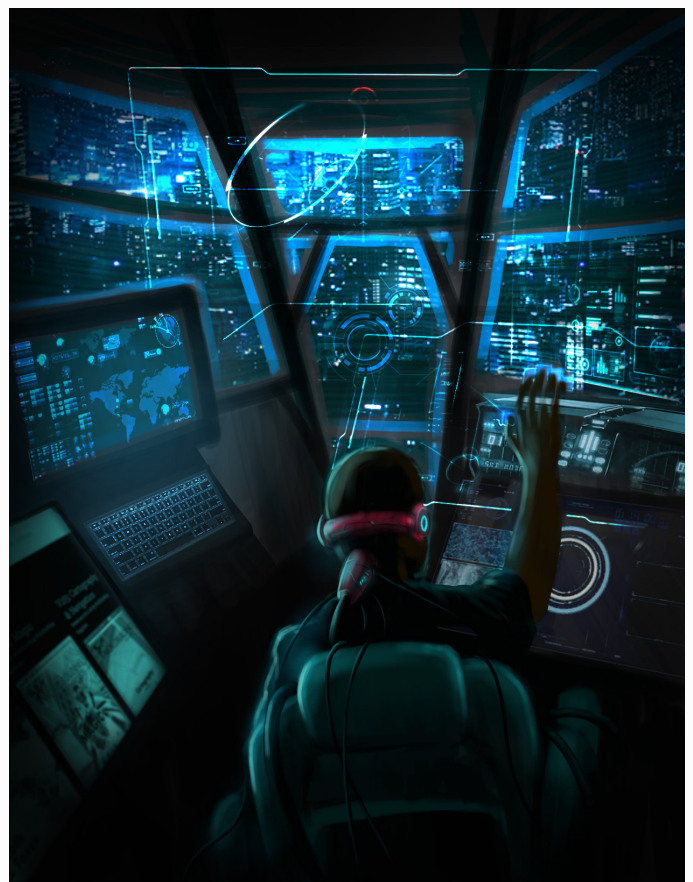
Punk music gave voice to a young, disenfranchised, and angry working class and dealt with problems on all scales, from the looming threat of nuclear war to being depressed. It shouted that society was screwed up—that not all was well and not all were equal. Eventually punk music exploded, attracting both popular and corporate attention. No longer an underground scene, the punk movement, anarchic and individualistic, immediately fragmented. Some combined the original punk ethos and style with new musical sources, evolving punk into a more refined sound. Some focused on particular parts of the punk ethos and served highly focused fan bases such as Anarchopunk and Nazipunk. The New Wave movement continued along the same musical tradition as earlier punk music but tried to avoid the baggage associated with them. Hardcore punk developed in contrast, doubling down on the hard edge image and pushing a hard, fast rhythm. Record and fashion labels tried to cash in on the aesthetic, commoditizing the movement and giving birth to pop punk. And a million Hot Topic stores sprang up across the nation like emo bourgeois flowers after a desert rain. A new lexicon emerged to distinguish the various camps as purists, sellouts, and posers.

Like music, science fiction is not a monolith, and new subgenres are born from a variety of social, artistic, and technological forces. Almost a decade after punk music coalesced, Bruce Bethke coined the term "cyberpunk," attempting to capture the

mix of punk's troublemaking attitude and the computer-driven future he could see coming. Just like the original punk movement, cyberpunk gave voice to people who saw a gritty reality of powerful corporations and disfranchised populaces. Also like the original punk movement, the genre quickly fragmented. Cyberpunk inspired a variety of -punk genres, their fans sometimes claiming hard stances on the purity of each one. The -punks are a messy, chaotic stew of overlapping definitions, decisive aesthetics, distilled worldviews, and ardent creator-fans. But more than that, as Joey Romone said, "All punk is attitude. That's what makes it. The attitude."

CYBERPUNK & BIOPUNK

Perhaps the most famous of these -punks is the cyberpunk school of the eighties and nineties. Bruce Bethke coined the word cyberpunk in a story of the same name back in 1982. Cyber- stemmed from the words "cybernetics," the science of replacing human functions with computerized ones, and -punk came from the musical genre and referred to a group of aggressive young people who eschewed convention. However, Gardner Dozois, a science fiction editor, is generally credited for popularizing the term.
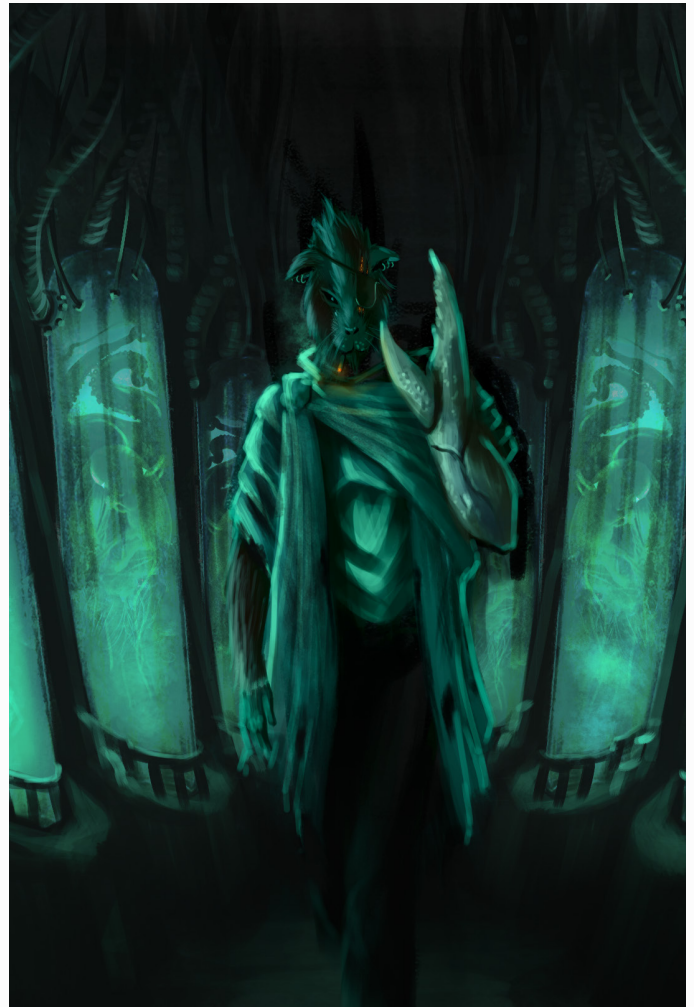
A subgenre of sci-fi, cyberpunk takes place in near-future settings that tend to focus on a "combination of lowlife and high tech." It juxtaposes advanced technological and scientific achievements (such as artificial intelligence and cybernetics) with some degrees of breakdown or radical change in the social order. Cyberpunk can also serve as an umbrella term for dystopian stories that depict dreary futures where information technology enforces governmental control and individuals receive mechanical or electronic augments.

Much of cyberpunk is rooted in the New Wave science fiction movement of the 1960s and 1970s. Writers like Philip K. Dick, Roger Zelazny, J. G. Ballard, Philip José Farmer, and Harlan Ellison examined the impact of drug culture, technology, and the sexual revolution while avoiding the utopian tendencies of earlier sci-fi. Released in 1984, William Gibson's influential debut novel *Neuromancer* solidified cyberpunk as a genre by drawing influence from punk and early hacker culture. Other influential cyberpunk writers included Bruce Sterling and Rudy Rucker. The Japanese cyberpunk subgenre began in 1982 with the debut of Katsuhiro Otomo's manga series *Akira* with its 1988 anime film adaptation popularizing the subgenre.

Cyberpunk plots often center on conflict among artificial intelligences, hackers, and megacorporations. The settings are usually post-industrial dystopias that feature extraordinary cultural ferment and usage of technology in ways never anticipated by its original inventors. Much of the genre's atmosphere echoes film noir, and written works in the genre often use techniques from detective fiction.

Several subcultures have been inspired by cyberpunk fiction, including the cyberdelic counterculture of the late 1980s and early 90s. Cyberdelic, whose adherents referred to themselves as "cyberpunks," attempted to blend psychedelic art and drug movement with the technology of cyberculture. Early adherents included Timothy Leary, Mark Frauenfelder, and R. U. Sirius. The movement largely faded following the dot-com bubble implosion of 2000.

Deriving from cyberpunk, biopunk focuses on the bleak near-future consequences of scientific and technological advancement. Unlike cyberpunk, it builds on synthetic biology (an interdisciplinary field of research that features concepts from biotechnology and genetic engineering, among others) instead of information technology, and individuals are usually modified and enhanced by genetic manipulation rather than cyberware. Biopunk generally examines the ethical pitfalls of synthetic biology, which can involve conflict with bio-hackers, biotech mega-corporations, and oppressive government agencies that manipulate human DNA. Its stories explore the struggles of individuals or groups, who are often the product of human experimentation, in a typically dystopian backdrop where totalitarian governments and megacorporations misuse biotechnologies for social control and profiteering. A common feature of biopunk fiction is the "black clinic," which is a laboratory, clinic, or hospital that performs illegal, unregulated, and/or ethically-dubious biological modification and genetic engineering procedures.

STEAMPUNK (AND FRIENDS)

While surrounded by some small debate, the origins of steampunk appear to go as far back as the scientific romances of authors like Mary Shelley, H. G. Wells, Jules Verne, and even the historical accomplishments of Charles Babbage's Analytical Engine. Midway through the 20th century, the genre was unintentionally born out of the literary works of Mervyn Peake and Michael Moorcock between the 60s and 70s. By 1985, the genre had even seen its aesthetics brought to life on the silver screen in the British-American cult film, *Brazil*. Though steampunk shares many similar -punk themes with its slightly older cousin, cyberpunk, the now-common term was not coined on purpose. The term came from an off-the-cuff statement by author K. W. Jeter who had written to the sci-fi magazine *Locus*:

Personally, I think Victorian fantasies are going to be the next big thing, as long as we can come up with a fitting collective term for [Tim] Powers, [James] Blaylock and myself. Something based on the appropriate technology of that era; like "steam-punks," perhaps.

Central to steampunk's aesthetic is the bleak, Dickensian retro-futurism visible in such eccentric creations as airships, automatons, and mechanical/clockwork prosthetics. The fashion meshes with the era of rich tailcoats, top-hats, corsets, petticoats, and parasols. Contrasting the excess of the higher class, blue collar workers wear overalls, aprons, rags, gas-masks, and even—as it seems necessary to mention—goggles. Factories stretch into the skies, belching acrid clouds of smoke. Homes and places of business are cobbled together from bricks, lit from within by gas-lamps, candles, or early electrical lamps. In some cases, steampunk even looks to the American West and attaches its Victorian fashion to the revolvers and spurs of ranchers, rangers, and ruffians alike.

Through the years, small schisms have divided the greater steampunk community. Purists battle it out with what they view as other genre "posers" that are often called by other names to separate their specific aesthetics from the more classical definition. Those looking to simply attach gears to things to make faux-steampunk creations are deemed "clockpunks". More romantic or supernatural writers are deemed "gaslamp Victorian" or "gaslamp fantasy" authors. When magic is added to the mix, works tend to be deemed "aetherpunk" (though the term hasn't quite caught on). Even the American Western take can be pushed under the umbrella of "cattlepunk."

Even in the light of steampunk's seemingly fractured fan-base, it is undoubtedly the next biggest -punk next to cyberpunk in terms of cultural influence. One need only search the internet for "steampunk" in order to find conventions, cosplayers, and various media showcasing the future that never was.

DIESELPUNK

First coined in 2001 by Lewis Pollak to market his role-playing game *Children of the Sun*, dieselpunk evolved from a steampunk offshoot into its own distinct subgenre. It is rooted in the period from 1920 to 1950 rather than the Victorian era, drawing literary influences from action-filled pulp and gritty noir. Dieselpunk diverges more strongly from the other -punks in its thematic influences. It can veer between the decadent hedonism of the Jazz Age to the earnest patriotism of the WWII era and the existential dread of modernism, but it often ignores the politics of disenfranchisement that underlie so many of the other -punks.

The aesthetic mixes the streamlined shapes of art deco, the bright brass of the big band era, and the experimental bent of the modernist movements. It's a style composed of chrome and steel, glass-pierced skyscrapers, oversized vehicles, and the oily grit that accompanies modern machinery. It has pin-up girls and fedoras, zoot suits and flapper dresses, cigarettes and gasoline, Rosie the Riveter and Uncle Sam Wants You. Technologically, the genre's hallmark depends on combustion engines (particularly the eponymous diesel engines), radio, and guns.

Although the term dieselpunk has not broken into mainstream consciousness, big budget Hollywood movies like *Indiana Jones*, *The Rocketeer*, and *Captain America: The First Avenger* have established its aesthetic. Because of them, most people can recognize dieselpunk as a cohesive genre, even if they don't know its name.

ATOMPUNK

Atompunk, a close cousin and immediate offshoot of dieselpunk, draws inspiration from the post-war Atomic and Space Ages. Some use the end of WWII in 1945 as the dividing line between the two genres, although others consider the advent of television in the 1950s to be the transition. Although atompunk shares some of the same art deco/streamline moderne aesthetic with dieselpunk (its slightly better known cousin), it generally has a brighter, more futuristic feel, with Googie architecture, Sputnik vibes, and cigar shapes. As *TV Tropes* puts it, "Everything is slick and streamlined, with geometric shapes and clean parallel lines constructed of shiny metal and glass, lit prominently by neon. Sweeping curves, parabolas, and acute angles are used to suggest movement—movement into The Future.... all decorated with little blinking lights that don't really serve any purpose (but they sure look futuristic!)." It overlaps the Raygun Gothic aesthetic; while some fans merge the two, others treat atompunk as the darker, dirtier side of Raygun Gothic. Those who differentiate between the two see atompunk as having less focus on sleek space suits with bubble helmets and more on radioactive fallout and existential dread of nuclear war.

Electronics and atomic power dominate the retrofuturist technology of atompunk—spaceships, radioactivity, scientific laboratories, rayguns, aliens, cathode ray computers, televisions, and jetpacks. It's sometimes optimistic about the power of science and the march of technology in a way that most -punk genres never quite capture. With the early Cold War as its cultural backdrop, some atompunk works lean into the espionage and space race side of the genre. Most atompunk stories ignore the patriotic

and military fashions widespread in dieselpunk. If dieselpunk is exemplified by *Indiana Jones* and action pulp, atompunk is exemplified by *Fallout* and 50's to early 60s sci-fi and Silver Age comics.

SOLARPUNK

Solarpunk is defined by its often optimistic outlook on the future. It has a few distinct aspects that separate it from the rest of the punk worlds which include focuses on community, equality, craftsmanship, and environmentally friendly technology using renewable resources. Solarpunk tends to have a high level of cultural awareness, gender equality, self-expression, and artfulness. It combines facets of biopunk, cyberpunk, and skypunk to create a lighter outlook. Solarpunk may have come to being out of a reaction to nihilism in cyberpunk.

Solarpunk has its cultural roots in both African and Asian cultures. This may be a byproduct of the Victorian/Edwardian era fascination with the "exotic" that accompanies the Art Nouveau veneer attached to the genre. This influence appears mostly in the artwork of *missolivialouise* who can

be considered one of the potential originators of solarpunk when she pushed the idea to the public on *Tumblr* in 2014. Even though solarpunk is usually characterized by a positive outlook, it can be utopic or optimistic. More importantly, it can provide social commentary by focusing on the struggles of the real world and looking for solutions to those struggles. The majority of solarpunk worlds focus on a free, egalitarian world where no one is better than anyone else and everyone has equal opportunities. Solarpunk worlds look to a brighter future by deliberately undermining the systems that keep it from getting to its ideal state.

The influences of Solarpunk mainly revolve around the environment. Concern for global warming led to a call for more eco-friendly solutions, which in turn ran into the creative arts. The threat of climate change unintentionally spurred a rejection of the bleaker visions of the future that most punk genres provide. In some ways, solarpunk artists and authors are punk to the -punk genres in that they refuse the negative outlook on the future and, instead, substitute it with a much brighter, more accessible potentiality.

It is also worth noting that Solarpunk is still in development. The other types of -punk genres have solid roots and criteria as far as what makes that type of -punk. This is part of why some people are reluctant to call solarpunk a full-blown genre: it lacks the clarity and identity necessary for acceptance. Without that solidity, few authors or artists have delved into what solarpunk has to offer. Hopefully, in the years to follow, we can officially add one more distinctive -punk genre to the already veritable buffet of choices.

-PUNK WORLDBUILDING

Like punk music, -punk genres within speculative fiction constantly evolve. They have distinctive, evocative styles, but resist clear-cut boundaries. We can try to define them by some combination of aesthetic influences, technological bases, and inspirational periods. We can try to link them by underlying themes, such as capitalism's inevitable corruption of society. We can point to how they center their stories around the literary analogs of the rebellious punks that so definitely defined the music scene—misfits and antiheroes, working class stiffs, criminals, inventors, and artists. We can see that in a lot of ways, they all embody the "high tech, low life" description of cyberpunk, but applied to broader definitions of tech and life.

However, the sci-fi -punk genres defy easy categorization as much as the real world punks hated to be put into neat boxes. Is steampunk still steampunk if it steals the style but drops the tech? Is dieselpunk really punk when it's unapologetically patriotic? Is solarpunk established enough to be a cohesive genre, or do the various strands that its adherents trumpet need to coalesce into a more solid idea? The fandoms that collect around each genre heatedly debate each other's true interpretations, not so much purists against posers as true believers disagreeing on dogma. Except the dogmas in this case are ossified into expected tropes that both signal the genre and restrict it.

As worldbuilders, this colorful, evolving set of subgenres gives us plenty of inspiration, but also a bit of a challenge. How do we write in the genre without it sounding like a rehash of unquestioned stereotypes? If we stray too far from the genre, we're not in it, but if we don't stretch the boundaries, it can be easy to make a tired copycat of earlier works. Here are five strategies to address that risk:

1. Lean into the genre. Identify the stereotypical aspects of the genre and analyze the roles they serve. Consciously use tropes to create emotions or themes rather than just subconsciously adopting them as part of your world. For example, when George Lucas developed Indiana Jones, he began by exploring what he loved most about the old serials he watched as a boy.[1] The resulting film enthusiastically embodies the pulps from which it draws, but doesn't feel tiredly derivative.

2. Break the non-core tropes. Find tropes that aren't central to the genre and explore what happens when you break them. For example cyberpunk stories classically envision a world ruled by multinational mega-corporations, often Japanese ones. But what if Nigerian companies ruled instead? Then you'd have an afrofuturist cyberpunk, a much less explored space.

3. Start from the basics. Choose a technology and cultural influences and work through how they shape the world. Avoid mindlessly copying the ideas others have already developed. For example, you may start with the same Victorian era steam technology ingredients as traditional steampunks, but if you didn't automatically add in goggles and airships and all the other accoutrements, what do you personally think steampunk would look like?

4. Start with new basics. There are a lot of different -punk genres that cover many combinations of technologies and styles. However, history is wider than that. Look for a less used period to draw from. For example, I don't think I've seen a -punk example using futuristic Polynesian style and technology based on a deep understanding of the ocean and tropical island practicalities.

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[1] Maslin, Janet. "How Old Movie Serials Inspired Lucas and Spielberg." *The New York Times*, The New York Times, 7 June 1981, movies2. nytimes.com/books/97/06/15/reviews/spielberg-filmserials.html.

5. Continue the conversation. Art reflects back on itself and can have interesting things to say about what's already been said. For example, Snow Crash by Neal Stephenson, with its hero named Hiro Protagonist and a world called the Metaverse, is a parody of cyberpunk as much as it is a standout example of it. 🪐
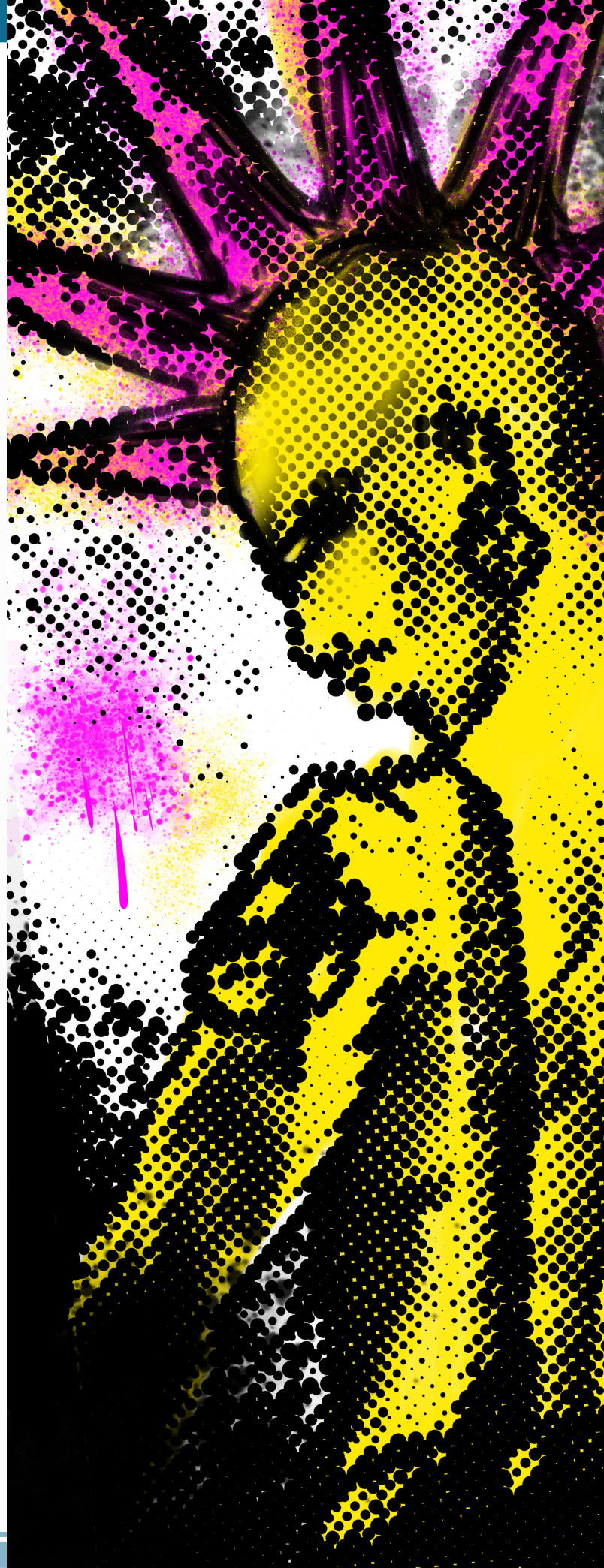
TECHNOLOGY COMMUNITY FEATURES

*Curated by Adam Bassett and Cathy,
the Overprepared GM*

During development of this issue we invited our readers to submit some details on technology within their worlds. We've chosen a few and are delighted to present them! From neuro-readers to biological computers, there's some truly inspiring ideas here.

I'd like to extend our thanks to everyone who took the time to submit their magic systems to us. It was a lot of fun reading through them. Keep an eye out for more community projects like this, and maybe we'll see you for the next one!

GRIST

by Ademal

A switch of a playlist; a total change of heart. I can press play on rage, stop on fear, and fast-forward on critical thinking. You're lost in the vanilla while I'm remixing entire experiences—the awe of spiritual insight merged with sex on a beach, the hitch of a kick of fear overlaid with the nostalgic feeling of campfire stories of your youth...

I could go on, but why should I?

I can't describe it to you. You have to experience it.

— From the lips of a Grister

Gristing is a mnemonic process of triggering a pre-programmed mental state by way of stimuli cues. This has a range of utility, such as halting panic attacks and inducing focus, but is also used to get high, enter states of berserk rage, and to torture prisoners of war.

*I needed a wash of peace, a hit of adrenaline, complete and utter focus, and a litany of righteous rage.
I didn't want to skimp out either—some Gristers are too fuckin' lazy and just go for the low-hanging experiences to record.*

Grists are created by recording lived experiences with a Neuro-Reader, editing them on software to tweak the outcome, and are programmed into the mind with a device called a Pavlovian Bypass. During the programming they are associated with a Mnemonic Key, known as a Grist Drop, which is later used to re-trigger the emotion. When the Grister experiences the drop, they are forced into the mental state with remarkable intensity.

Programming a Grist into someone is a personalized process which must be done on an individual basis.

Aight, I edited the hell out of it and I've made a God. Damned. Masterpiece. Seriously, I might as well quit and rest on my laurels. Considering what I'm intend to use it for, I may just have to.

I have just the name for it.

Due to its ability to alter psychology, Gristing is prohibited to various degrees by the different Banners. The exception to this is House of Sorrows, whose hit squads use it to amp up before a strike. This tradition has earned them a terrifying reputation, and is the basis of most anti-Gristing sentiment.

"SICK PUPPY"

The Drop played out over our comms as we repelled in through the windows. The crackle of gunfire illuminated the room, bathing our target in a white glow as blood blossomed from their chests.

"SICK PUPPY"

I revisited the constituent components of the Grist in order, and felt again all the same thoughts and feelings I had experienced when I recorded them. Absolute calm, like I was moving in a bath of salt water as fingers ran through my hair.

Under that, fire, cold fire. The thud thud thud of his fists colliding with my ribs and my heart thundering like gunfire in my chest. It was like falling pumped up on Adrenalol from a great height, but with total certainty of a safe landing.

I was merciless, a machine made for killing, a…

SICK PUPPY

SYSTOME

by Barron

SysTomes, designed by Hepburn and Luncaster Group, are a series of customizable and expandable electronic devices. They are designed to store massive amounts of data on a subject to assist the user with any menial or complicated tasks involving that subject.

HISTORY

SysTomes came from a desire to have more connectivity with the ever-expanding wealth of knowledge flowing from every corner of the universe. The founders of the SysTome originally created their product as a stylized compendium of different topics pulled by algorithms from all the search engines in existence. Over time, as their product gained more popularity, they created their own ever-growing and curated knowledge databanks.

USAGE

These electronic tomes are purchased to assist those needing accessible compendiums of knowledge. Doctors, technicians, lawyers, engineers, and many more use SysTomes to ensure they are up-to-date and can find any information they need to run their day-to-day job.

A doctor can read up on any new found disease by setting the SysTome down and opening its holographic pages. Entire figures and animations of common surgeries can be pulled up alongside the doctor, guiding even the most novice surgeon through some of the most complicated medical procedures to date.

These SysTomes are expensive to purchase, but come loaded with the most current knowledge of the user's preferred subjects. They can be updated in real-time as long as there is an Æthernet connection. The knowledge they contain can be expanded to include more subjects by purchasing expansion chips. The SysTome itself is a physical cover with holographic technology inside. Searching can be done in an instant using communication implants.

AN ADVENTURER'S BEST FRIEND

Many of the more wealthy adventurers can be found using SysTomes to help them with their work away from home. Adventurers often need compendiums of known beasts, planets, wildlife, and survival skills, and a SysTome with enough expansion chips can hold all the knowledge required. Even in the most remote locations, a SysTome can remain in operation as long as there is a power supply to recharge its week-long battery life.

EXPANSION CHIPS

Expansion Chips are memory plug-ins and licences for different aspects of technology and knowledge. They are an expensive upgrade to an already expensive piece of technology, but there are dozens of expansion slots. The most novice of adventurers can become one of the most knowledgeable people in the universe if they have an upgraded SysTome in their possession.

SINGULARITY DRIVES

By B. K. Bass

As mankind began to spread out among the stars, they had to rely upon naturally occurring faster-than-light travel routes through space provided by wormholes. While traversing these phenomena greatly reduced the time to travel through the cosmos, it limited the number of potential routes and destinations. Also, a ship departing Earth would have to travel for almost ten years to reach the nearest wormhole. Once they exited on the other side, these early pioneers and colonists would have to travel another three to five years to reach their destinations traveling at nearly 80% of the speed of light using fusion engines.

A revolution came about in 2247 when an international coalition of physicists and engineers, funded by a number of governments and powerful corporations, developed a method by which mankind could create their own wormholes. With this new technology—dubbed the Singularity Drive—mankind was no longer at the mercy of natural wormholes.

Singularity Drives operate by utilizing enormous amounts of stored energy to create two overlapping fields of electromagnetic energy in front of the ship. These fields collapse as more energy is poured into them, creating two artificial singularities that share a portion of their gravitational fields with each other. One of the singularities is then propelled with an intensely focused beam of electromagnetic energy with an opposed polarization to the original containment bubble. This pushes the second singularity across space at super-luminal speeds only possible for such a point of nearly infinite density. (This is an overly simplified explanation, as there are a number of other factors at play during the process; such as quantum entanglement.)

As the distance between the two singularities grow, the shared gravity field between the two stretches to create an artificial Einstein-Rosen Bridge—the interior portion of a wormhole. The magnetic bubble containing the nearest singularity is then expanded, opening the mouth of the artificial wormhole to allow the ship to pass through. Within moments of the ship's passage, the wormhole begins to close behind it. Once inside, the ship must continue at full speed or risk being crushed by the contracting gravity well that is collapsing behind it.

There are several dangers that exist in the use of a Singularity Drive. The most drastic of which is loss of magnetic containment of the singularity itself. While not massive enough to create a stable black hole, the resulting gravitational implosion could easily destroy an entire planet. Also, should this happen within the gravity well of a star, the gravitational effect could easily disrupt the orbits of several planets permanently.

The ship and her crew also brave many dangers, such as the risk of a miscalculated exit point. Exiting the bridge into the corona of a star or in the middle of a debris field are just some ways such travel can end in catastrophe. Also, should the ship not maintain enough velocity or its own protective electromagnetic field, the bridge itself could collapse and crush the ship.

THE NET

by James Griffiths

The Net, much like its forerunner, the internet of the 20th and 21st centuries, is a data transfer system, designed to enable high-speed transfer between the 16 Arks. These massive generation-ships ferry the remnants of mankind to the stars in search of their new home.

Unlike the ancient internet, the Net uses computers that are entangled at a quantum level to transmit the data between each Ark. It serves as the primary data highway between each Ark, allowing each one to transmit data about population levels, fuel levels, and status reports.

It serves as most citizen's first view of the sun, their first-time swimming, driving a car, drinking and tasting the millions of flavours that ancient Terra offered humanity. By accessing the Net with a neural interface, known as a cyberjack, people on every Ark can experience a life outside the metal walls of

the hab-rings. Using a combination of quantum computers and the user's mind, the Net also contains a vast digital universe that each person can experience through neural stimulation. Drawing on the memories and experiences of the 4 million people that originally boarded the arks, the Net generates a fully tactile, fully interactive world for every user to explore. It is an escape from the grim reality that the men and women aboard the Arks experience.

The computers that house the Net were originally built to contain an AI that would produce blueprints for the colonist ships. The intent was that, eventually, the network would allow the colonists to accelerate their journey, allowing humanity to reach and inhabit a new world in a fraction of the time. However, when the AI project failed to produce an adequate system, a rival company, Cybos Industries, produced the Net. They sold it to the colonists as an "escape from the bland interstellar void."

Now, the Net is more than that. It is the centre of politics and where the citizens of the Arks live their day-to-day lives. In the digital universe contained within, Clans of people search for the next great challenge, and Lancers sell their services to the highest bidder. The real world has been abandoned for the digital paradise of the Net.

Usage of this alternate virtual reality does come with certain dangers, however. Because of the lack of physical exercise and lower gravity on the Arks, individuals must comply with an intense dietary and physical regimen to avoid bone and muscle atrophy. There have also been a number of mysterious deaths surrounding the usage of the Net; occasionally, an individual will be found dead in their quarters, their minds trapped eternally inside the digital construct. The cause of death is often attributed to power surges, but it's believed they live on inside the Net as spectral beings called Digiwraiths.

POTENTIUM CATANODE

by Ianara Natividad

The potentium catanode, short for "potentium arca-catalyst nodal unit," is the most common energy source used in Nuhight City, a northwestern megalopolis on the continent of Macai. Potentium catanodes usually serve as the "perfect fit" for energy needs due to their refinement process, which can create variations in potential energy output to suit specific purposes. Industrial grade catanodes sustain Nuhight City's power grid and public transport lines, while smaller catanodes fuel market technologies, such as handheld lights or personal weaponry. Depending on the nature and extent of use, a properly assembled catanode can provide clean, sustainable power for as long as three hundred years.

Raw potentium appears as an ore that glows with condensed elemental energies. In this form, it can become volatile through prolonged exposure to heat, light, or air. To use as a stable power source, potentium must first be refined into an arca-catalyst form. Refinement requires extreme amounts of physical pressure combined with bursts of energy (such as those produced by magic or magical effects) concentrated on an ore sample. The ore sent through refinement typically range from 2 to 50 centimeters in diameter, depending on the intended placement of the future catanode. A successful refinement creates a potentium arca-catalyst shaped like a prism. The arca-catalyst has transparent to translucent sides, except for two dull faces. Larger ore samples can produce arca-catalysts that have a higher number of sides, which positively correlates with potential energy output.

To create the nodal unit, an arca-catalyst is fitted into a base frame according to size and potential energy output. The nodal unit's base frame, called the "body" of the potentium catanode, fits tightly over the prism. A silver-steel alloy usually makes up this frame, though silver-mithril and silver-adamantium bodies can better accommodate higher energy prisms. Typically, every edge is covered by the frame with plating on as many as half of the sides. Two conducting handles, referred to as the "mind," are then attached to the arca-catalyst's dull faces. The mind connects the catanode to

machinery, including interfaces for controlling energy output. In the final step, a circuit pattern is lightly etched into the frame with gem dust (quartz being the lowest quality while diamond is the highest). Circuit patterns dictate the actual energy output of a potentium catanode while doubling as a safeguard to prevent volatile malfunctions.

DARMSTADT PROCESSORS

by Koray Birenheide

"We enjoy independence from the fickle forces of what was once called 'destiny', the waveform collapsing De Vries Field[1] of the Great Clockwork, thanks to the technology we use to suppress its influence. But we must never forget that we built our advanced society on a foundation of magic and technamagic research in ages past. As we move forward into a new age, we should not forget these roots and the great debt we owe to the Great Clockwork. Today, we are a mankind grown. Today, we say farewell to the house of magic in which we grew up as a people. Today, we build our own house, start our own family. But we shall not forget the magic that enabled us to grow up, and we shall not see ourselves on too high a pedestal when criticizing its use by those still living in the bosom of the Great Clockwork..."

— Dr. Inv. Vincent Kunibert Greenhorn, 23rd of Manwhe, 25 GE, on the day the DVF Suppressors of Borealis were permanently activated.

One of the non-magical inventions believed to be the most fundamentally necessary for the voluntary abolishing of magic is this: the fabled Darmstadt Processor.

In the historic year of 146 of the Age of Awakening, within the still existing Maritime Technocracy of Guantil-ya, Prof. Dr. Inv.[2] Mark Darmstadt constructed his very first Darmstadt Processor: the first complex computation machine using biological components to function.

Slow and bulky technamagic resonance computers had been used before this point to make complex calculations for genome mapping and certain projects requiring the procedural application of predefined algorithms, and they were necessary in calculating certain aspects of the intricate circuitry of the Darmstadt Processor. When the machine was completed, the advanced computer age began for the technocrats of Guantil-ya, and they would exponentially outgrow the rest of the world within a couple of centuries.

The first three versions of the Darmstadt Processor were built using a Guantil-ya Kelster gerbil's brain and spinal cord. The signals a MK 1 processor could compute and the ways in which it could process them were extremely basic, and working with the prototype MK 1, Prof. Dr. Inv. Darmstadt had to make extensive use of existing resonance computers.

The preexistence of technamagic computers introduced an incredible shortcut to the development of Darmstadt's bio-computer, and with its help he was able to create a very rudimentary operating system for the wired gerbil brain. Over the history of Darmstadt Processors, a variety of rodents and other animals were tested for their brains' compatibility and efficiency as computers, though the research would always lead back to mice and rats, which, luckily, were easy to breed.

Today's Darmstadt Processor rats are a genetically edited version of Sternsmooth fancy rats, optimized for use in modern builds. 🪐

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1 Discovered by Dr. Helen De Vries, De Vries Cluster Field Theory postulates that the collapse of quantum wave functions via the Great Clockwork and, in a much smaller way, sentient life forms, is the origin of magic. It works via the manipulation of theoretical particles.
2 An Inventorate is equal to a Doctorate but pertains to an applied and/or experimental field.

REACHING FOR THE STARS

DESIGNING SPACECRAFT FOR HARD SCIENCE FICTION

B.K. Bass
Art by Anna Hannon

As Mathias ran along the corridor, the metal deck rang out with every footfall. Crewmen ducked out of the way to give the officer room to pass as he shouted, "Make way!" He stumbled as the ship lurched, and he could hear an explosion coming from the engineering section. He tapped a comms relay on the bulkhead. "Bridge, report!"
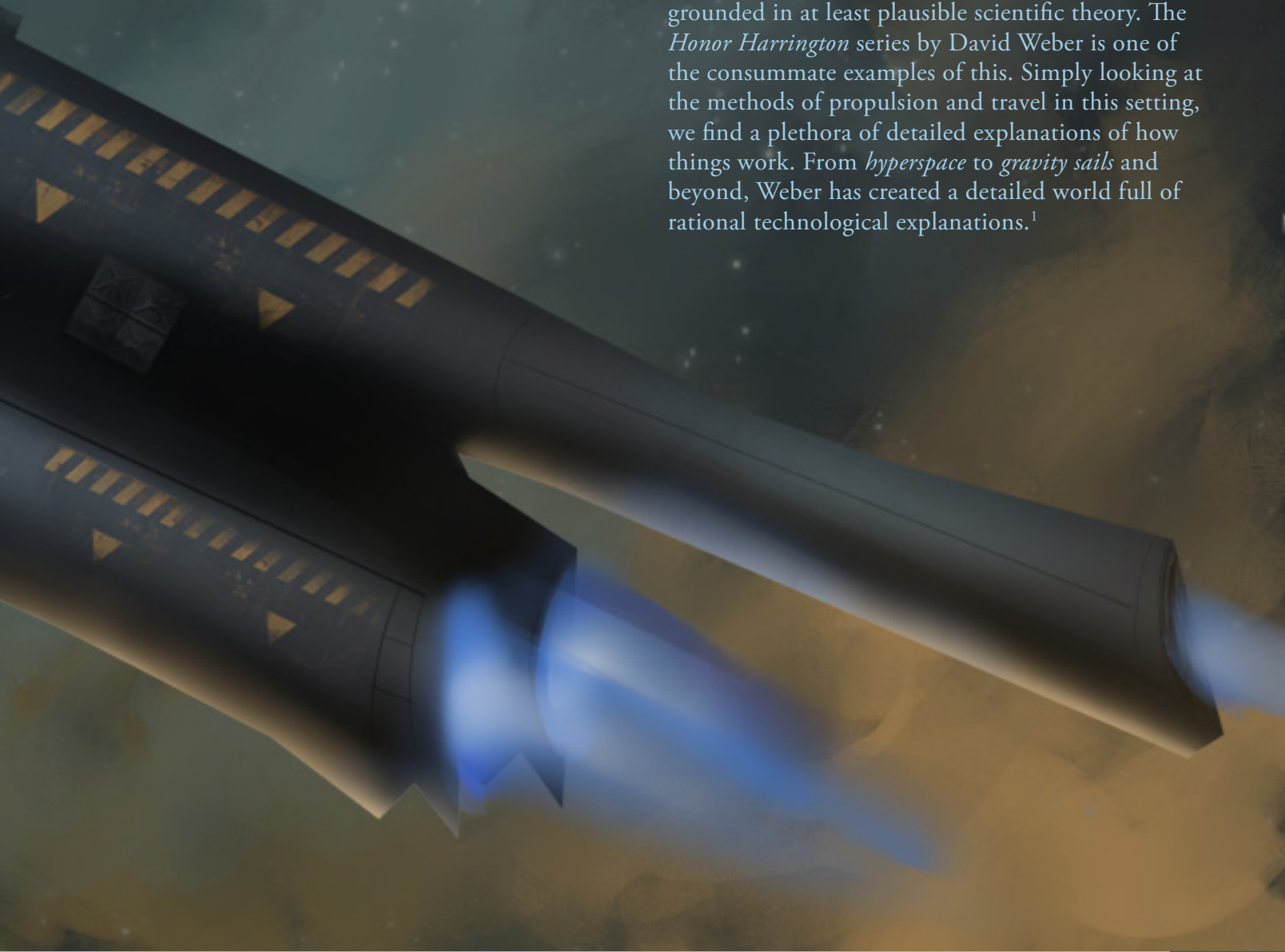
There was a moment of static, then Cali's voice came over the speaker. "We've taken a direct hit in the aft section. Reactor two is offline. There are power fluctuations all over the ship and the main thrusters are offline."

Mathias held on tight as the ship rocked again. "Use the secondary thrusters," he said into the panel. "Try to get us closer to the Gustavson. Contact Captain Harris and tell him we need cover from his point-defense batteries."

Who doesn't enjoy a roaring space battle? The intensity of a life-threatening conflict, combined with the deliberate pace of behemoth spaceships pounding away at each other, is a wonderful dichotomy that can be explored in many ways. And with an entire crew of characters to flesh out, we have ample opportunity to show interactions between them.

But as our intrepid spacefarers are running along the deck in frantic desperation, a question comes to mind: why aren't they floating through the corridor in the low-gravity environment of space?

This—and many other questions—are of paramount importance if you're going to design a spacecraft for a science fiction setting. While many franchises are very successful using strategically placed handwavium and technobabble (the *U.S.S. Enterprise* from *Star Trek* just popped into your mind, didn't it?), others have taken pains to ensure that every aspect of their starfaring ships are grounded in at least plausible scientific theory. The *Honor Harrington* series by David Weber is one of the consummate examples of this. Simply looking at the methods of propulsion and travel in this setting, we find a plethora of detailed explanations of how things work. From *hyperspace* to *gravity sails* and beyond, Weber has created a detailed world full of rational technological explanations.[1]

Engineering an entire spacecraft from the ground up is a daunting task; not to mention our science fiction setting requires us to establish physical laws and prerequisite technologies before we even begin to think of laying the keel of the ship itself. Were we to discuss every aspect of these processes, we would most likely be able to write several volumes of books before we even began to scratch the surface of this massive undertaking.

Rather than attempt to condense all this information into a single article, we will instead explore some of the major questions related to worldbuilding in science fiction, with a focus on how this will—in the end—result in spacecraft that are grounded in a rational system of physical laws and plausible technologies. In the interest of simplicity, we're also going to assume we are working with a human civilization, as alien technology is its own can of space-worms.

I'm very excited to be delving into this topic, as I've recently been working on answering the same questions for my own science fiction worldbuilding project called *Astra Nautica*: a military science fiction setting for a new series of books which will take place primarily aboard a ship. I'll be using examples from it to illustrate the application of these ideas throughout this article.

A note on balance: Although we are going to be looking at designing spacecraft with as much real-world technology and scientific theory as possible, we are still discussing science fiction. Depending on how far forward we are looking, there will come a point where we have no choice but to inject elements of *technobabble* or *handwavium* to fill in the gaps of our current understanding of reality or our ability to manipulate its elements. The goal here is to limit these speculative elements, but not to eliminate them outright. You will see some examples throughout this article where this limit is reached, and the *fiction* is injected into the *science*.

WHAT IS OUR POWER SOURCE?

Any craft we develop will need a way to generate massive amounts of energy. Propulsion aside, ships have an extensive array of systems that rely upon electricity. But, how much electricity does a ship need? Looking at existing modern naval technology can give us a good benchmark to start with.

The American *Nimitz*-Class aircraft carrier uses two A4W Westinghouse nuclear reactors, producing a total of 190 megawatts (MW) of power, or 1,664,400 megawatt-hours of energy per year (energy = power * time).[2] In comparison, the average U.S. household consumes 10.4 megawatt-hours (MWh) of energy per year.[3] This aircraft carrier is generating enough energy per year to keep 160,038 homes running. When they say an aircraft carrier is like a city at sea, they can even include the amount of energy it is generating!

With this in mind, we can then consider what systems our craft will need, beyond those of a modern aircraft carrier. This aircraft carrier has an impressive array of electronics, such as computers, communications systems, radar, sonar, lighting, kitchen appliances, and an array of moving parts like aircraft elevators; not to mention the turbine engines that propel the vessel. Our spacecraft is also going to need things like life support systems, water purification and recycling systems, and—depending on what other technologies the ship needs—may also power things like lasers, inertial dampeners, and artificial gravity.

Looking at these systems, we can rightly assume that any spacecraft of an equal size to a modern-day ship will require much more power. Exactly how much is difficult to quantify given all the theoretical technology involved, but this still gives us a good base to start with.

HOW ARE WE GOING TO GENERATE ALL THAT POWER?

The most obvious answer is to use what exists now: nuclear fission reactors. One problem we will run into here is that fission reactors, such as the A4W, are water-turbine reactors. These reactors heat water into steam to turn a turbine, and it's this motion that generates the electricity. Our aircraft carrier can easily vent the steam and scoop up more water from the sea, but our space-borne vessel will need a closed system to condense the steam back into water and pass it back through the reactor. We will also have to haul a *lot* of water along with us.

Looking to the immediate future of large-scale, sustainable power generation, we come to nuclear fusion reactors, which are currently in development. The ITER reactor, under construction in southern France, is a prominent example of this. It is a tokamak reactor (a theoretical design developed by scientists in the U.S.S.R. during the 1950s) which will use the fusion of two hydrogen isotopes (deuterium and tritium) to generate superheated plasma. The reactor is projected to have an output of 500 MW.[4] This is more power than four modern naval fission reactors, enough to power two of the above-mentioned aircraft carriers.

In my own project, *Astra Nautica*, the fusion reactor is what I settled on. Of course, my design is set several hundred years in the future, and—thanks to technobabble—the reactors of the future are much smaller than the ITER tokamak! This is a good example of where we can take an existing technology and inject some speculative elements. Of course, we need only look at our own recent history to see a trend of miniaturization across all fields of engineering, from mechanics to computing and beyond. It is therefore not a giant leap of faith to assume that the same will happen to newly developed technologies; rather, it's to be expected.

Beyond these technologies, we are approaching the boundary of pure speculation. Several future power-generating technologies have already been proposed, such as the antimatter reactor. In this device, particles of matter and antimatter are introduced into the same environment. When they collide, these particles annihilate each other, resulting in the release of astounding amounts of energy.

We can also simply invent our own power source, but if we are trying to stay firmly within the bounds of hard science fiction, we must tread carefully. One could say a ship is powered by a *Roddenberry-Lucas Reactor*, but we need to establish the rules of how this works within a plausible framework. The more hypothetical our power generator is, the more handwavium we will need to keep it running.

HOW WILL WE GET THERE?

Now that we have a power source figured out for our ships, we must decide how they are going to move around. Modern spacecraft use a combination of solid and liquid fuel rockets, as well as reaction control thrusters for maneuvering. All of these have one drawback for long-distance space travel, especially if we are hoping to achieve high speeds and maintain the ability to maneuver regularly: fuel.

If we have established that our ships will be equipped with some sort of power plant that can generate enormous amounts of electricity, we already have an alternative to hauling large amounts of fuel. Scientists at NASA are currently experimenting with ion engines, which use electricity as a primary energy source. These engines bombard a propellant with electrons to create ionized particles with a high energy state, which are then emitted through a thruster. The potential power output of these engines, compared to their mass and fuel storage requirements, makes them much more efficient than other conventional propulsion systems.[5]

The total power output of these engines is still limited, so if we're hoping to create enormous colony ships or lumbering battleships, we will need to develop some more creative means of getting around.

There have been a lot of theories on how to go about this. Concepts such as solar sails are among the more fantastic to consider, even though they are thought by modern engineers to be a viable solution. A similar option is a laser sail, although this would require a system of laser emitters to be stationed along usual routes of travel, and would limit a ship from setting its own course. One of the more dramatic ideas I've seen is setting off nuclear explosions behind a ship while using some sort of shield to absorb the blast, riding the shockwave through space like a star-bound surfer.

Needless to say, there are too many potential options to discuss them all in detail. The most important point to remember is that—just like with our power-generation technology—the more we ground our propulsion systems in real-world tech, the more believable they will be. I've tackled this question for my Astra Nautica project, and this is the result:

The fusion drive reactor is designed around a cylindrical reaction chamber. The energy and fuel inputs are all located at the fore of the reactor, with

high-frequency laser emitters used to introduce energy to the reaction, resulting in super-heated plasma.

The magnetic containment field is polarized in a way that encourages the plasma towards the rear of the reactor, which connects to a primary thrust nozzle. This nozzle is likewise equipped with a polarized magnetic field that further accelerates the release of the plasma, creating an enormous amount of thrust. In addition, the electricity generated by the reaction can be used to power supplemental ion drives, and the helium by-product of the reaction is typically stored for use in maneuvering thrusters.

—Astra Nautica by B.K. Bass

As you can see from this example, the fusion reactor that I chose to use as an energy source also drives the primary engines, secondary engines, and maneuvering thrusters, but they each operate in a different manner and utilize different by-products of the reaction. This efficient use of resources is something that any starship engineer will hope to accomplish.

WHAT IF IT TAKES TOO LONG?

One of the challenges our intrepid space-faring community will face is the time involved in traveling long distances. Travel within our own solar system is currently measured in terms of years, and interstellar travel would take tens of thousands of years. Even with our speculative propulsion systems, relativistic law still limits us to traveling below the speed of light (or *c*), about 300 meters per second.

The best estimate for travel to Alpha Centauri I found over the course of my research was in a paper authored by Darrel Smith and Jonathan Webb of the Embry-Riddle Aeronautical University. They proposed theoretical models to create a ship propelled by an antimatter rocket that could reach 50% c, which they dubbed the *Antimatter Photon Drive*. By their calculations, a ship weighing 400 metric tons (Mt) and carrying 170 Mt of fuel could reach Alpha Centauri in 9.59 years. (Due to time dilation, from the crew's perspective only 8.41 years will have passed.)[6]

The problem we are faced with, then, is the human factor of spending that much time on a voyage. Anyone who has been on a long car trip with children will understand the terror of spending ten years hearing, "Are we there yet?" This humorous aside illustrates the key problem here: the psychology of boredom. With the automated systems and programmed trajectories of our hypothetical interstellar vessel, there will be little for the crew to do but wait until they get there.

Even at higher speeds, time dilation creates a whole new set of problems. As an object approaches the speed of light, time passes for that object (and its occupants) at an exponentially growing rate as compared to the rest of the universe. As an example of the ramifications of this, I highly recommend *The Forever War* by Joe Haldeman. In this book, only a few years pass for the protagonist while over a thousand have passed on Earth!

Relativistic physics aside, what are we to do with the crew of the ship while it spends years traveling between the stars? Even with Smith and Webb's proposed antimatter drive, we are looking at about ten years as a best-case scenario. Travel to more distant stars, or travelling in heavier ships, will take much longer.

A common trope seen in science fiction is that of putting the crew into hibernation or stasis for most of the voyage. This solution is so prevalent because the idea is sound: there are already several theories regarding how one might accomplish this, ranging from cryogenic storage to chemically induced comas. A number of medical concerns are associated with this trope, most notably the ill effects of such long states of inactivity on the human mind and body. Methods for stimulating both neurons and muscles while in hibernation are a large concern. While the cryogenic option might eliminate the need for these systems, the act of freezing and thawing a human being has the potential to cause massive amounts of tissue damage.

In my own project I've explored both cryogenics and hibernation, and explained that, due to the damage caused by cryogenics, chemically induced hibernation has become a favored method. Of course, in this case the human metabolism is still

active and must be sustained. Breathing assistance apparatus, feeding tubes, and electro-stimulation for the muscular system all must be in place. Even with these precautions, I have theorized that there will be a substantial rehabilitation period required after the journey, and plan to have my passengers awoken several weeks before arrival in order to facilitate this.

CAN WE GO FASTER?

As mentioned above, the physical laws of the universe, as explained by Albert Einstein in the *Special Theory of Relativity*, preclude any object from moving faster than the speed of light. Because of this, the answer to this question is quite simply "no, we cannot go faster."

If there wasn't a 'however' after that, this would be a very short section indeed! Fortunately, there is.

However, we can look for ways to travel through space that don't involve going faster than the speed of light. These methods are commonly referred to as faster-than-light (or FTL) travel within the genre, and a remarkable number are already available to ponder in the realms of literature, film, and television. Any fan of the genre has surely heard terms such as hyperspace, warp drive, space-fold, and jump drive tossed around. In some instances, the mechanics of how they work are glossed over entirely. In others, there is actually a very good explanation for the science behind the fiction!

One might be surprised to learn that a theoretical technology for accomplishing this has already been proposed. This technology, called the Alcubierre Warp Drive, was proposed in 1994 by Mexican physicist Miguel Alcubierre.

"To put it simply, this method of space travel involves stretching the fabric of space-time in a wave which would (in theory) cause the space ahead of an object to contract while the space behind it would expand. An object inside this wave (i.e. a spaceship) would then be able to ride this region, known as a 'warp bubble' of flat space."

This is what is known as the Alcubierre Metric. Interpreted in the context of General Relativity, the metric allows a warp bubble to appear in a

previously flat region of spacetime and move away, effectively at speeds that exceed the speed of light. The interior of the bubble is the inertial reference frame for any object inhabiting it."[7]

While this seems similar on the surface to the warp drive technology used in *Star Trek*, it is actually very different. In that universe, a bubble is created around the ship similar to that used by the Alcubierre drive, but the ship is still considered to be in motion as the bubble warps the space around the ship.

Other practical theories about FTL travel include the use of wormholes as a shortcut between two points in space—folding space so that the origin and destination point align—and jumping through space by means of some sort of long-range, instantaneous teleportation. This concept was notably demonstrated with the Bajoran Wormhole in Star Trek: Deep Space Nine, and recently in the movie Interstellar.

This last idea might still break the rules of relativity in some models of the universe, as the 'universal speed limit' also applies to energy. Looking at new models based on quantum physics, however, one could easily stretch the truth and use quantum entanglement as an explanation for jumping from one point in space to another. In fact, *quantum teleportation* has been proven possible in laboratory experiments, and Chinese scientists have actually transferred the quantum state of a photon on Earth to another in orbit on a satellite 1,400 kilometers away.[8] This is a far cry from teleporting an entire spaceship across interstellar distances, but it still serves as a proof-of-concept.

The approach I settled on for *Astra Nautica* was using wormholes as shortcuts through space. While wormholes do not provide an instantaneous voyage from an origin to a destination, they theoretically can reduce the distance travelled by way of cutting across the curvature of space-time. I felt this was ideal for a fiction work, as there would still be some travel time in which to develop character interactions. In fact, I even developed a system by which my ships can create their own artificial wormholes, called a *Singularity Drive* (More about this can be found in this issue's community technology section, on page [x]). Admittedly, this

design is composed of a handful of handwavium and a liberal dose of 'this looks good on paper,' but therein is where we earn the word '*speculative*' before our 'fiction.' It's good to have the foundation of actual science, but the fun part is playing with the 'what if' that comes next.

WILL OUR CREW WALK, FLOAT, OR STRAP IN?

I'm sure that everybody has seen astronauts floating around in the International Space Station on television, and—if you're old like me—in the space shuttle as well. Since this is an obvious reality of space travel today, the simplest option for our speculative vessels would be to illustrate a similar environment. Exploring the challenges of spending months or years in a weightless environment is a fascinating prospect, and writing a narrative where everybody is floating around would present an interesting challenge. One could play around with the concept of there being no 'up' or 'down' and create a very dynamic environment for their characters to operate within. *Ender's Game* by Orson Scott Card is a perfect example of this. Throughout their training, Ender and the other cadets were faced with a weightless environment. His eventual success came from thinking outside of a two-dimensional plane and utilizing the three-dimensional space to his advantage. Here we can see that the weightless environment not only added character to the setting, but was also a key plot point for the narrative.

Still, there is something to be said for the familiarity of having a character walk from point A to point B. One of the core concepts of speculative fiction is mixing the familiar with the strange, but we must be careful that our setting is not so unfamiliar as to be jarring. With that in mind, having some sort of artificial gravity on board our ships would do wonders to set scenes with a physical dynamic that our readers can easily understand.

We can create artificial gravity in a number of ways. One method that has been used many times in science fiction is having sections of a ship rotate to simulate gravity, thereby exploiting the laws of centrifugal force. The ship *Discovery One* from the 1968 film *2001: A Space Odyssey* is a popular example of this application.

One must keep in mind that the rotating portion of the ship must extend quite a distance from the ship's center to create an even field of force. If the ring is too small, you might experience an environment where your head was weightless and feet were plastered to the deck! This can cause many issues, from disorientation to hypoxia in the brain as blood is drawn to the lower extremities. Also, if the ring is too small it will have to rotate much faster in order to simulate the proper gravitational force. Any ship designed with a centrifugal ring would need to be very large, and the ring itself would need to rotate quite slowly.[9]

Another method of achieving artificial gravity is to consider the thrust of the ship itself. A craft accelerating at 1G of thrust will pull any occupant on board to the rear of the ship with a force equal to Earth's gravity. Taking advantage of this, one could arrange the decks perpendicular to the craft's main source of thrust, making it feel as if one is standing on solid ground. Likewise, the craft could flip over and do a 1G burn to decelerate, achieving the same effect in reverse. A great example of this from fiction are the drop ships from the *Battletech* universe, which operate as described above.

Beyond these options, any sort of artificial gravity flies into the realm of pure speculation very quickly. Barring magnetic plating and boots (which would not actually simulate gravity, but merely adhere the crew's feet to the deck while *they* remain weightless), I haven't seen any plausible theories on creating an artificial gravity well onboard a ship. If we want our ships to have decks parallel with the keel design—as modern naval vessels do—and still be able to walk

upon them, we're going to need to use quite a bit of technobabble to explain how this works. In my own project, this is the approach I plan to take.

Whether our crew is floating through the ship or strolling along the corridors, we also must consider the movement of the ship. Acceleration, deceleration, and maneuvering are all going to cause objects and personnel inside the vessel quite a bit of discomfort! Fortunately, we can utilize an already-established trope to solve this problem. Anybody who's ever watched at least a few episodes of *Star Trek* has heard somebody shout, "The inertial dampeners are offline!" (Insert camera shake and actors jumping across the set here.) The term inertial dampeners has been used in many other works of science fiction, and it very plainly implies that the system is counteracting the forces applied upon the occupants by the ship's motion.

While there is no scientific background for how this might work, this trope is necessary if we want our travelers to enjoy a smooth flight. Again, my own plans for *Astra Nautica* are to include this sort of technology, although I have not fleshed out the details as of yet.

Alternatively, we can restrict the acceleration and maneuvering of our ships to account for this issue. In this setting, our ships will truly be ponderous objects unable to make any dramatic course changes.

Our final option is one that allows our crew to float in zero gravity and deals with the issue of intense inertial forces during maneuvering. We can simply have our crews strap in to padded seating with safety restraints any time the ship is in a situation where it might be called upon to make sudden changes in velocity or momentum. The television series *The Expanse* from the SYFY Channel illustrates this option very well, and has been praised for its realistic representation of both space travel and combat between space vessels.

PUTTING IT ALL TOGETHER.

By now, we've discussed most of the concepts that we must grasp if we are to design a spacecraft where both physics and logistics apply, be it a small cargo freighter or a massive battleship. We have covered

power generation, propulsion systems, long-term spaceflight, faster-than-light travel, artificial gravity, and maneuvering concerns. This framework still only covers the broad strokes. There are many more questions, and—as I have stated—answering them all could fill volumes.

Some other things to think about are how large the ship will be; what kind of materials it will be made of; how much cargo room is needed for supplies; how it will store, recycle, or generate breathable air and potable water; and how many crewmen will be needed to operate and maintain the vessel.

A key consideration in answering these questions is what the function of the craft will be. A small interplanetary freighter will be much different from an interstellar colony ship [lumbering across the galaxy], just as the design of an orbital patrol boat will be vastly different from that of a battleship ready to deploy across the void of space. One must also consider that most ships do not operate in a vacuum (the vacuum of space aside). Will this be a long-range scouting vessel designed to be independent, or part of a military fleet full of support craft? Knowing the ship's purpose and support structure will help to determine not only how to answer the larger questions discussed here, but also what questions need to be answered beyond them.

BONUS SECTION: YOU SHOULD SEE THE OTHER GUY.

Up until now, we have been looking at the design process of science fiction spacecraft from a human perspective. As we all—theoretically—*are* human, this is only natural for us.

What about designing ships for alien races? The questions to ask ourselves are much the same, but we can take liberties answering them when considering vessels of an alien civilization. While we should still consider the laws of physics, we can also introduce more speculative elements, depending on how exotic our aliens are. Exotic power sources, undiscovered elements, and unconventional geometry are just a few ways in which we can differentiate alien ships from our own.

One thing I would stress is focusing on the anatomy, psychology, and sociology of the aliens themselves. For the purpose of creating a setting for a work of fiction, how the aliens interact with the interior of the ship will be our largest opportunity for exploring new ideas in these exotic settings. I would focus on the small details with this. Consider something as simple as a chair: if the species is not bipedal, the base design of a chair might be completely foreign in comparison to our own. One can also play with social concepts. If the species is less collaborative than we are and tends towards isolation, an open bridge staffed by many officers might be replaced by a series of individual compartments, each controlling a different function on board the ship, with little to no communication between the operators.

PUTTING IT INTO PRACTICE.

These and other concepts can be used to create an immersive setting full of rich details in which our characters can interact with each other. Building our setting upon a solid foundation of scientific fact helps to make the story more believable, encouraging a level of immersion that brings the narrative to life in ways not always possible in soft science fiction.

Once we have all these physical laws, technologies, and systems figured out, I would advise against dumping all of the information onto your reader. Sprinkling in small details over the course of the narrative is the best way to make the setting realistic. Keep in mind that you do not have to tell the reader everything you have developed for the setting. If it pertains to the plot and the character in the moment, then—and only then—is when it should be mentioned. The purpose of worldbuilding for fiction should always be to have the information available and to build a believable foundation for your world. Not every fact needs to be shared. 🪐

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THINKING SIDEWAYS ABOUT POST-APOCALYPTIC TECHNOLOGY

By Robert Meegan
Art by Adam Bassett

When you start to create a world, one of the most important aspects that needs to be determined up front is the *theme* of the stories that you want to tell. Common themes include exploration or the struggle between good and evil. Some of these are universal, working across all (or at least many) genres, while others tend to fit one particular form of storytelling. Resource management, for instance, is a theme that works particularly well in science fiction of all forms.

On the surface, that sounds about as exciting as a parent-teacher association meeting discussing school band funding. However, when the resources are food, water, and fuel, without which your people are going to die, it gets a lot more interesting. Even better, there's no need to create artificial deadlines for achieving objectives when starvation or suffocation provides natural tension. An outstanding example of this is Andy Weir's *The Martian*.

The post-apocalypse (PA) is also a terrific setting for worldbuilding with a resource management theme. You have an environment the audience recognizes, relatable characters, and gasoline-fueled warriors of the wasteland. What's not to love?

If you had to pick a golden age for the subject, it would probably have been the early eighties. The USA was standing toe-to-toe with the Soviet Union—Ronald Reagan staring into the eyes of Leonid Brezhnev and Yuri Andropov, wondering who would blink first. There were terror attacks, wars in the Middle East, Mount St. Helens erupting, a global recession, and Duran Duran became the top-selling band in the world. Things could hardly have looked more bleak.

There was another advantage back then as well: there was a lot of '50s and '60s technology still around. Automobiles and trucks could be maintained in the driveway with the tools found in every garage. There were factories and machine shops in every major city and even most small towns. Eating fresh, healthy food grown locally was a ridiculous idea, and the shelves were stocked with cans and boxes loaded with preservatives. There's a reason that the *Mad Max* films, *Damnation Alley*, and *A Boy and His Dog* all put heavy emphasis on food and vehicles.

Sadly, the end of civilization isn't what it once was. Fast forward thirty-five years and the end of civilization may be no less likely, but it's certainly less exciting in some respects. Whereas a nuclear attack was then deterred by the prospect of a massive retaliation, what holds it off today is the knowledge that you'll be either bombing the factories that provide low-cost electronics or the multi-million dollar foreign apartments bought to launder money. Pig-headed sabre-rattling and chest-thumping may be the order of the day, but the reality is that it's all about economics, and destroying the world is bad for your profit margin.

The most likely cause for the end of the world now is probably climate change, but it's happening in slow motion. A fifty-year-long death spiral is a real existential threat, but even if the end result is the same, there is a lot of time to prepare. It lacks the air of breathless terror that makes the "lifeboat" scenario so appealing, which is one explanation for the rise of the zombie apocalypse as a subgenre. It's implausible, but at least it has the advantage of quick, horrible death on a global scale. There would likely be little opportunity to plan for the aftermath in any meaningful way.

If we want to work with a resource-limited world, there are a few key considerations. The end of all things should be relatively quick, taking a matter of days or weeks. It should be deadly, killing ninety percent or more of the human population—at least in the areas that matter to you. Finally, it should come as, more or less, a surprise, allowing for minimal preparations. This last element doesn't mean that no one was prepared; there might be supplies hidden by survivalists. Rather, the idea is that the general public and authorities were not able to properly plan and execute procedures, such as manufacturing and stockpiling materials specifically for distant future use.

When creating a post-apocalyptic setting, the amount of time passed since the disaster needs to be considered. The sweet spot lies sometime around twenty years after the fall of civilization. Much earlier than that and it's all about surviving the apocalypse. Much later and it's a whole new world. Both are legitimate environments, but the characters and situations are very different. Fifteen to twenty years allows for the presence of survivors from the old world, along with the knowledge that they have about technology and science. It also allows for a generation of adults born and raised in the new world. Developing new production capabilities, rather than scavenging from ruins of the past, becomes necessary, as by this time the obvious caches such as stores and distribution centers have been cleared out.

WHEN THE WORLD IS RUNNING DOWN

This is where most PA worldbuilding either devolves into petroleum-blooded terrorists rampaging across endless barren wastes or blood-thirsty murderous gangs prowling through vacant city streets. Ignoring the fact that these have been done many times over, they both suffer from a lack of energy.

Literally.

Gasoline has a very short storage life. In the United States, where it is almost entirely blended with ethanol, gasoline kept in a proper storage container under normal conditions will deteriorate badly within ninety days. This is why most lawn mowers sound like they're about to die an agonizing death: they're probably running on stale gas that's lost the more volatile compounds and absorbed a great deal of water. Unblended gasoline may double this life, but it ends up the same way. Even extremely refined racing fuel in sealed containers is best used within a year.

Diesel fuel can last somewhat longer as long as it's not exposed to moisture. It's less volatile, so that's less of a problem, but even small amounts of water lead to fungal and bacterial growth that will clog filters and injection ports. At best, it still only has a storage life of about two years.

Ironically, modern engines are more sensitive to these problems. They are designed to be more fuel efficient and cleaner while delivering more power in a smaller package. At the same time, they can run far longer before requiring extensive maintenance, such as replacing fuel filters and spark plugs, and service of components such as valves and rings are no longer done before the economic life of the engine has expired. Tighter mechanical tolerances and electronic controls have made this all possible.

A glovebox of the past often had a screwdriver and wrench to allow adjustment of the carburetor or distributor timing when the engine ran badly. In contrast, a modern engine generally needs a well-equipped facility, including sophisticated computers, for analysis and tuning. An engine with minimal electronics and a tolerance for bad fuel will have a very high value. Those engines usually belong to vehicles with an old-school chassis that has an undercarriage frame which can serve as the basis for useful modifications, pushing their value even higher. One particular vehicle would be worth its weight in canned peaches: the legendary M35 2½ ton truck used by the U.S. military and its Continental LDT-465 engine, which can run on diesel, gasoline, jet fuel, or kerosene without complaint.

In the cities, things are going to be pretty dark and miserable. While burning trash piles can be used for warmth in the streets, disappointingly few apartments are equipped with coal-burning stoves or even functional fireplaces. The limited supplies of kerosene lanterns and candles won't last more than a matter of months, let alone years. The cities of the 21st century are designed for electricity.

Few inner cities are likely to have more than a handful of portable power generators available, as most residents in non-apocalyptic times don't have the room to store them or a place to run them safely. The most promising option would probably be for a group to band together and use a backup generator from a hospital, skyscraper, or computer facility. Once again, this solution would quickly run into the fuel problem, not to mention the fact that these large units are generally built into the structure of the building, rendering them effectively immobile.

Even in the most incredibly optimistic scenarios, our wasteland warriors are going to be reduced to mountain bike-riding maniacs. In cities, the population will diverge into easily distinguishable subspecies: one with enormous quadriceps from hours spent pedalling power generators and the other with bulging deltoids developed from thousands of pulls on generator starter cords. While these environments definitely have the potential for deliciously absurd storytelling, they lack a certain epic scale feeling that one normally associates with the genre.

I'M ROCKIN' THE SUBURBS

It's time to start looking at the the problem of the modern post-apocalypse *sideways*. What can we change to make it different and more interesting?

The obvious step is to do what most people do when they realize that city life isn't for them: move to the suburbs. This is an idea that is significantly underused for a PA setting. After all, there are plenty of places to live and scavenge, and backyards serve as nicely pre-fenced areas for gardens and raising of small animals such as pigs, goats, and chickens. A homestead could consist of several neighboring houses where one acts as the primary dwelling, another as a barn, and a third for storage.

The problem of generating electricity gets easier if you pick an area with the right climate (both atmospheric and political). A substantial number of houses in sunny regions, such as Florida, Arizona, and Southern California, already have solar panels, and moving them from one house to another is not particularly difficult. Parts of Europe and China are also starting to see growth in solar power, making them candidates for our suburban enclaves.

It's easy to imagine what such a community might look like, with schoolyards and parks converted to grazing areas in a return to the idea of community commons. The schools themselves can serve as storage, meeting areas, bunkhouses for single adults, and as schoolrooms for the teaching of both old and new knowledge. A high school woodworking or mechanical shop would be a particularly valuable resource.

Some of the residents' first efforts might be to strip nearby shopping centers of virtually everything that could be hauled off to the commune in order to secure the goods away from roving raiders. A larger community would be able to make better use of stockpiled goods because all sizes of clothing would be usable. The effort required to move large quantities of building materials would be justified by the additional opportunities to make use of them.

Trades such as plumbing, carpentry, electrical, and mechanical work would be highly valued, while people who had less practical jobs in the past would spend their time growing food and tending the livestock. Those too old or injured to contribute physically could teach.

In many ways, suburbia would be an ideal environment to start the rebuilding process, but there remains one small problem: transportation. The suburbs tend to be more spread out than inner cities or even small towns. Once the nearby stores have been emptied, the next cluster may be several miles away. Hauling the recovered supplies would become increasingly difficult. The community will have to develop production capabilities for items such as clothing fairly quickly.

I SING THE BODY ELECTRIC

The obvious answer is electric cars. With electricity available, it can be used to charge up the batteries. While hordes of Teslas, Leafs, and Bolts silently making their way along the roads lack the terrorizing atmosphere of roaring V8's, they should be highly effective at getting people and goods from one place to another, even if only in small numbers at a time. Even better, electric cars require far less maintenance than their gasoline counterparts.

Except for the batteries. Therein lies the rub. It is a sad fact of chemistry that batteries deteriorate over time. They lose capacity, in terms of how much total energy they can store, and they lose the ability to discharge that energy, reducing the maximum current flow. This situation exists for every known rechargeable battery available today.

Lithium-based batteries are the best commercially available options today and are what most electric vehicles use. The technology is new enough that the average life of an automobile's battery pack isn't well known nor is the shelf life of unused batteries. Teslas, which have excess capacity and software designed to mitigate the deterioration, are estimated to remain fully functional for ten to twelve years. Assuming a sufficient number of available cars, they may see usage about two or three days a week. With that benchmark, most of these cars should be showing significant decreases in their range and top speeds by the twenty-year mark.

Another unfortunate point to bring up: solar power is only available during the day. At night, everyone will have to sit in the dark. A clever electrician could probably wire automobile battery packs to provide power for light and heat at night, but this luxury would come at the expense of their availability for use in the cars. Trade-offs would need to be made between nocturnal energy and mobility. While it might seem as though the vast number of lead-acid batteries used for starting engines could store electricity for use at night, they have a very short life, whether in use or on the shelf. Within seven to ten years, virtually all of these would be useless.

PIGS ON THE WING

As always, we can dig deeply into our box of ideas and see what's in there to make our version of this environment more interesting. Let's start by taking a look at one of the most iconic bits of post-apocalyptic worldbuilding: *Mad Max Beyond Thunderdome*. It's hard to deny that Bartertown was brilliantly conceived and executed, filled with details that made it memorable.

Not the least of these was the power source for the community: *pigs*. Or, to be more precise, a byproduct of the end result of pigs. To paraphrase the discussion in language more appropriate for a family publication, the town's power came from the methane produced from hog manure, which the pigs manufactured in large quantities. As it happens, the movie is spot on. It is indeed possible to generate electricity (along with a lot of heat) from hog manure.

At this point, I'm going to reach into a part of my box of ideas that probably doesn't overlap with yours. Our professional careers expose us to many elements of the real world that can provide fertile ground for ideas. It doesn't matter whether you're working in a coffee shop or the space program, there are daily things that you can slip into your box for future use. As it happens, I've had what can charitably be called an *interesting* career, so my box has a lot of things stuffed into it.

I've had the opportunity to visit a couple of hog farms that actively produced electric power for nearby towns. The movie had the right idea, but

the reality is a little more complex. The manure is pumped into huge tanks called bioreactors where it ferments, generating *biogas*. Biogas is a combination of methane, carbon dioxide, hydrogen sulfide, and water. The methane makes up about 60% of the biogas.

Manure does produce biogas, but silage produces more. About seven times more in fact. Silage is generally corn (maize) that is cut and chopped while still green. This material is then piled in huge storage bins where it ferments. When fed into a biodigester along with enough manure to make a properly fluid slurry (you really don't want to know), the end result is enough net energy—even including the cost of planting, fertilizing, harvesting, and transporting the crop—to provide lighting, heating, and cooking for about forty people per hectare.

Obviously, a farming community is going to be more sustainable than an urban or even suburban counterpart, but it still seems a bit dull. While a farmstead is a bucolic setting, it seems more appropriate for a simulation game than for an epic adventure.

THE ANSWER IS BLOWING IN THE WIND

Our little rural band is pretty nice, but what it needs is a little jolt. Fortunately, farm country already has the answer. Travelling through the fields of the American Midwest or Europe, it's impossible to miss the towering wind turbines that poke up out of the countryside like monstrous flowers. Each of these has a generating capacity of one to two *million* watts of power. Even with very conservative assumptions about their usable capacity (the wind doesn't always blow hard enough for full power and there is maintenance downtime), one of these turbines could supply the basic electrical needs for ten to twenty thousand people.

What's more, wind farms host clusters of these turbines, some of which contain hundreds of them. It wouldn't be hard to build a town surrounded by a half-dozen or more turbines while keeping some off-line as spares. Since these turbines have a design life of twenty to twenty-five years, careful maintenance and a practice of rotating active turbines could

Anastasia Palagutina

likely provide power for forty to fifty years, far outstripping any other options.

All of the work that we put into designing our suburban and biogas communities isn't wasted, though. The biogas generator can serve as a backup power supply for those days when the air is either too calm or too stormy for the wind turbines. More importantly, it can serve as a fuel source for the vehicles of our community.

In our pre-apocalyptic world, compressed natural gas (CNG) is replacing diesel and gasoline as the fuel for vehicles of all types. It burns cleaner, and in North America, it is significantly less expensive. Transit buses and delivery vehicles most commonly use them, but alternative fuel engines and aftermarket conversion kits are available for everything, from huge semi-tractors down to pickups and passenger cars. These engines can run on the biogas, often with nothing more than some minor adjustments. They have roughly the same travel range on a load of biogas as their petroleum-fueled counterparts, creating the opportunity for grand expeditions covering hundreds of kilometers.

What's at least as important is that the farm equipment, such as tractors and harvesters, can be converted to run on biogas as well. This technology will provide our survivors the incredible increase in productivity made possible by moving from manual subsistence farming to a modern mechanized environment. Compared to pre-mechanized agriculture, modern equipment can produce two to four times as much food per area but with only one-fortieth the labor. This efficiency frees up individuals who would be pushing plows or gathering grain. In a curious turnabout, the farming community is able to use people with education and advanced technical skills for teaching and other quality-of-life activities far better than the suburban enclaves.

The relatively vast amount of electrical energy allows our community to run a fairly large induction furnace capable of melting up to about 1500 kg of steel scrap (or the same volume of most other metals). This material, in turn, could be fed to a complete machine shop able to create hundreds of small items, such as personal tools or weapons, or very large pieces needed for spare parts or modifications to existing vehicles.

A steady supply of electricity makes a plethora of other functions possible. The ability to refrigerate and freeze food opens up additional opportunities for storing meat and dairy products that are hard to preserve otherwise. A deep reserve of generating capacity lets the community make use of power-hungry operations such as taking x-ray images and welding. Electric pumps can bring water from deep wells or streams to irrigate crops, while greenhouses stay warm and lit, providing fresh vegetables even in the winter months.

As always, we can look at our creation from the perspective of a visitor. What would be the experience of someone coming upon our community? Let's imagine a handful of survivors from an inner city. They range ever farther in the effort to find food and necessities while battling rival gangs scrambling for the same scraps. Finally, after holding out for fifteen years, they decide to find a better life.

Moving out into the remains of the surrounding suburbs, they find communities of a couple hundred people. The smell of animals and gardens draw the city people on the wind, but they find those enclaves surrounded by high fences covered with rusting razor wire and armed guards watching from towers. These folks are familiar with raiders from the city, and they have defenses to hold them off. Some might be willing to provide food and supplies to peaceful parties, while others might be more inclined to shoot first and not worry about asking questions later. In any case, unless some recent event has lowered the population, these places aren't looking to take in new residents.

Perhaps our survivors linger for a while in the outskirts of the city, unwilling to completely abandon what they've known. Eventually, they'll find themselves in the same situation of having to search picked-over neighborhoods, looking for things missed by previous hunters. Once again they set out, this time into the wide countryside, perhaps on a rumor of a place far away where civilization still has a hold.

Weeks pass into months as they wander across the plains. Starvation almost overcomes them until they discover that even abandoned farms still have gardens where carrots and greens have gone wild. They eventually learn to catch rabbits and even the occasional deer. Still, they move on until one day they hear strange sounds in the distance.

Cresting a hill, the visitors first notice a pair of wind turbines gracefully spinning above fields filled with corn and wheat. Cattle graze in the shadows of other turbines that have their blades feathered against the wind. Unlike the chaotic prairie that surrounds them, these fields have neat rows of crops and farm equipment moves through and around

them. Well-kept houses are clustered in groups, and there is a collection of large buildings from which steam rises. On the edge of the community, a pair of heavy trucks roll up to the main gate with an escort of a half-dozen smaller vehicles. One truck is loaded with scrap metal, while the other appears to have household appliances still in their boxes. A bell rings, and children run out of a building and start to play at a well-groomed park.

Our survivors turn and look at each other, dirty and wearing threadbare clothing. In the years since the fall, the largest group that they have met have numbered barely two hundred. They've seen people killed over a can of vegetables. All they have known is privation and suffering.

Their eyes meet. They look back at the vista before them. What is this place? What kind of welcome can they expect? Are the residents glad to see newcomers, or will they fight to protect what they've built?

Putting it all together, we've taken our post-apocalyptic setting from random bands of scavengers desperately trying to slow the slide into barbarism to a thriving and dynamic community capable of rebuilding a stable civilization. We used our toolbox of knowledge and experience to create something rich and complex that can serve as firm foundation for storytelling and adventure. From the ruins of the old world, a new one begins. All built on the idea of resource management. 🪐

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EXCLUSIVE INTERVIEW:
QUASAR

Inteviewed by Aaryan
  Art from Species

FANTASY

CULTURE

GAMING

NATURE

James Schumacher, aka Quasar, has been developing Species, a simulator game that allows players to control and watch the real-time evolution of virtual organisms. Here's how he describes it in his own words.

Quasar: *Species* is an emergent evolution simulator. It places a population of creatures in an artificial environment, and those who survive to reproduce pass on their genes. Each time they do, the offspring is slightly mutated. Natural selection and genetic drift forces emerge from that basis, and realistic evolution emerges from those. While I'm building what I hope will be a fun video game, the simulation itself is the center-point of the whole project.

Sounds like a huge undertaking. Where did the inspiration for the project come from in the first place?

Ultimately, it can probably be traced back to 2005/2006 when I found a tiny, petri-dish game called *Primordial Life* that simulated single-celled organisms. I thought it was amazing and went looking for a larger, 3D macroscopic-scale evolution simulator, under the assumption that someone must have already made what was (to me) such an obvious idea. When I found nothing that matched what I had in my head, I started jotting down design notes of my own. A few years later, I started coding it.

Primordial Life can't be found online anymore, as far as I know, but there's a very similar game out there called [Biogenesis](#).

I should probably note the elephant in the room here: *Spore*. I didn't find out about *Spore* until after I'd started work on *Species*, but when I learned about it, I distinctly remember feeling disappointed that a big studio had "beat me to it." I quickly realised, though, that under the hood, *Spore* had very little

in common with the game I was working on. *Spore* was a top-down, cells to space role-playing game, while what I wanted for *Species* was a bottom-up simulation with actual evolution.

Y'know, I had a very similar reaction when I learned about Species. That's what gets me about the game, as a student of science. It's something that really resembles population-scale macroevolution in a video game.

How do you go about even beginning to create this level of simulation? What was the workflow and thought process behind choosing specific characteristics to mutate and interact with the environment?

The primary design goal behind *Species* was to see evolution happening in real time, so at first I focused on traits and genes with obvious visual characteristics: body parts, musculature, and skin type, rather than internal organs or behavioral systems.

Once I had a basis for genetics and appearance, it turned out the most complicated features were "artificial," for lack of a better term. "Species" (the category) doesn't exist in nature. It's a human concept that evolution defies. There can be a continuum of creatures that can and can't breed, or there can be sterile creatures that can't breed with anyone, yet are still members of their parent species.

But I'd already written myself into a corner by deciding that the game would be called *Species*, so I had to do something. I ended up defining "species" with a concrete definition of my own: a set of creatures capable of mating with at least one other member of the same set. One of the more complicated routines in the game continuously analyzes the population for speciation events, where the "connecting" creatures between two populations die off.

This system ended up being the basis for the real-time clade diagram, which would be my favorite feature of the game if it wasn't so damn *annoying* to work on.

For what it's worth, it's probably my favorite feature. Could you explain the clade diagram?

A clade diagram, cladogram, or "tree of life" (if you're not a pretentious biology enthusiast) is a graph of the evolutionary relationships between two species. It shows what modern species evolved from and how long ago they diverged from a common ancestor.

Gotcha.

So delving into other features: what's the user's experience when they enter the game? What are they attempting to do? What can they see? What kind of tools might they have?

Species allows you to customize various aspects of the world—including temperature, fertility, and starting creatures—before entering it. The default creatures are small, tube-like chordates called *Primum specium* (lit. "First Species"). Generally, they will quickly infest the world and start evolving into more complex and efficient forms. The player can't control creatures directly, but they have tools to manipulate their environment. For example, making the world colder will generally prompt them to evolve insulation and warm blood.

There are also more direct interaction tools: the 'player avatar' is an artificial intelligence with access to rovers and various biological research facilities. Players can use the gene editor to make creature templates and then apply artificial selection in the nursery to 'make' a creature resembling the template, or they can gene splice the template into living creatures directly.

At the moment, the game's a strict sandbox. Goals are entirely player-defined. In the future, though, that will change. Gameplay will be built around a facsimile of science: observing the evolution of wild creatures and using experimentation to build up a library of body plans, genomes, and fossils. Sampling and comparing this data will lead to unlockable tools and features: new rover parts, new genes you can add to your synthetic genomes, and new body parts you can artificially select for. Plus, there will be a certain amount of lore (I intend to leave much of the backstory of the world and AI ambiguous, but to do that, I need to first imply that there is a backstory) and some encyclopedic information for those people who find words like "homeotherm" interesting and just must know more.

Wow, sounds like a lot of bold stuff going forward.

What's your background in all of this? Obviously you're a coder of a good degree of talent, but how did this evolve into something so grand over the years?

I'm a science enthusiast, but I don't have any degree or credentials. Most of my knowledge comes from natural interest and—I'm slightly embarrassed to admit—far too much time spent aggressively debating creationists when I was younger.

Ironically, the game started as a small, simple idea to learn the ropes of game programming. Something I could build without worrying about screwing it up. I just sort of... never stopped developing it, and my ideas grew as I got more comfortable with the technology.

What's the response been like as you moved to Steam and really pushed the project forward?

Moving to Steam has been great. It's been a massive motivation boost for me, and the extra feedback, both positive and negative, has been extremely helpful. It's prompted me towards features (Max/Linux Support and multithreading for performance) that I likely would have continued to procrastinate on had it not been for that feedback.

Are there any particular stories, screenshots, or moments from either yourself or the community that really encapsulate the game for you, off the top of your head?

It'd be hard to pick one. Just about every video on the game features at least one horrifying abomination of nature and/or science. But the experience for me, as a developer rather than a player, is probably best encapsulated by some of the bugs.

For a while, the game had a problem where tail-length wasn't clamped above 0. This meant that creatures could (and did) evolve 'negative length' tails that were inside-out and stuck out from their body in... a suggestive direction. But the reason they kept evolving this is because they were getting a survival benefit. A negative tail has a negative growth cost, which meant growing creatures could gain energy from it. The creatures found the bug before I did, and they evolved to take advantage of it, which allowed me to track it down.

That's a neat trick. How much of the balancing when it comes to growth cost/survival is self-correcting, and how much requires tinkering once you've got it afloat?

Pretty much all of it requires some level of tinkering. The creatures are very good at finding ways to exploit or abuse edge-cases. However, that's got less to do with me trying to control the outcome and more to do with me wanting the world of *Species* to make sense on an intuitive level. Fast creatures should look fast rather than abuse some weird quirk of the speed calculation to teleport around the map.

Makes sense.

So what are some of your main takeaways with respect to evolution, having spent so much time working on the nitty-gritty of survival advantages? Any interesting quirks or tips that might help the average worldbuilder guide their own species-development process?

Carnivores are harder to evolve than you'd think. They need a lot of space and a very large pool of prey organisms to feed on. You won't find the perfect hunter on a small island or otherwise isolated ecosystem.

Diversity is correlated with how long it's been since the last mass extinction. A realistic post-apocalyptic world, for instance, will not have a diverse array of organisms. Deepwater creatures tend to be very sensitive to pressure and temperature as they come from an environment where both are constant.

And remember that creatures don't evolve by trying to achieve something. The mutation comes first. A creature that evolves a long neck does so because there is edible foliage all the way up the tree and being slightly taller helps reach more of it, not because they 'want' to reach the leaves at the top.

Oh and lastly, genetic drift is a valid explanation. A slightly boring explanation, admittedly, but sometimes creatures just change. Not every feature is a result of natural selection.

Neat. With people trying to build their own races, sometimes these things can really spark ideas and help guide worldbuilding. Ultimately, what do you hope people will take away after playing your game?

Ultimately, I hope they just enjoy the time they spend with the game, find it interesting to watch, and fun to play. But I do also hope people come away with a better, or at least more intuitive, understanding of what evolution is. If it can help replace some people's linear view of an ape becoming a man with the more nuanced image of common ancestry reflected in the clade diagram, that'll be plenty for me. 🪐

You can find Species on [Steam](), the [official website](), the [forums]() and the unofficial [Discord channel]().

THIRTY THREE TALES OF WAR

Emory Glass

I: FARMER

One-hundred and twelve years the homestead stood, an isolated dwelling east of Mavska village where the pines were sparse and the mountains steep. His great-grandmother had settled the land when it was but a patch of wild turnips. Through hard work and determination, she had raised a respectable farm: a broad field lush with oats and cabbage, a patch for turnips and beets, a sheepfold, a goat pen, a cow for milking, and hens for eggs. On sheer obstinacy, she raised three buildings—a storehouse, a barn, and a home—alone. A hardy woman, his great-grandmother, but if she saw the farm now, she would surely weep.

The farmer stood quietly in the middle of his yard, thinking violent thoughts as an Ochetski war party beheaded the chickens, slaughtered the cow, and cast out their bedrolls wherever they pleased as if they had been invited here. The War Chief had already commandeered his home.

Heathens. Savages. Primitive know-nothings hired by the Yellow Queen to fight in her war. He scowled. Their War Chief, a scarred woman with muscles bigger than his own, pulled her *shashka* through the neck of his prized goat. His uncle had given him that goat when he came of age.

He glared at her. She, who had no shortage of piercings in her bony face, wiped her blade clean of blood without so much as a glance in his direction.

There would be no consequences for this. There never were. The Upperbirths got to cower inside their walled cities, the lowbirths beneath them safe inside their hovels. But those beyond city walls? Those out in the country, the true heart of the nation once called Kandrisev? Nobody gave a damn whether they lived or died.

He crossed his arms, watching as two warriors appeared from inside the house with a chair in each hand. The Yellow Queen didn't scare him. This war didn't scare him. By the gods, he hadn't even known there was a war until his family left to fight in it last spring. Mother, brother, sisters, all gone. He, the youngest, was left to watch the farm. But, for some jaw-clenching reason, this girl, this wild *beast* with her sharp sword and strong arms frightened him to the very roots of his soul. It didn't matter if they were on the same side. It didn't matter if the homestead laid in the western mountains of Chariv, where the Yellow Queen sat on her throne salivating at the thought of deposing a fifteen-year-old girl in the north. Nor did it matter if the War Chief had no reason to trouble him beyond quartering in his home. Yet here he was, soaked to the bones with fear.

A distant thought crossed his mind. Last he spoke to his mother, she mentioned a caravan of Ochetski traders who stopped at the homestead before heading to Mavska. Apparently, many skilled metal-weavers walked amongst their ranks. A flirtatious caravanner had presented her his dream amulet as a parting gift one morning. The emeralds alone had kept them fat over winter.

The farmer glanced around. Everyone seemed too busy rifling though his belongings to notice him. He shuffled inside his home. If three emeralds had kept a family of six in such good shape, surely whatever these raiders had would see him alone through next summer.

The War Chief had, of course, taken his bed. As he got down on his hands and knees, he decided the charge for such intrusion amounted to one emerald—or whatever other precious things he could find. He peered underneath the frame. Nothing but cobwebs and dust. He felt the mattress seams for metal or string. Empty. Grunting, he upended the mattress.

"Aha," he said to himself. A leather pouch. He dumped it out on the floor. To his delight, a necklace tumbled out, along with some smooth stones and feathers. He picked it up. It was a simple ring of silver divided like eight wheel spokes with a knotted cord. A few beads were strung through the middle. One looked particularly valuable, what with the streaks of gold…

He stuffed it in his vest pocket and put the other things back in her pouch. Good enough for him. He'd given them food, beds, and more leeway than they deserved. This amulet would pay their debt nicely.

The door handle turned. The farmer jumped. The War Chief stepped over the threshold, dropping her cloak at the door. She began uncoiling her bun. The tail end of her braid nearly fell to her waist. He gulped. If Ochetski heathens were anything like other Candrish ren, long hair was reserved for those with particular status or wealth.

When she noticed him, she startled. Her face darkened. Each thud of her heel on the dirt floor sent a jolt of fear though his chest. She held within striking distance. Before he could move back, she grabbed his chin and pulled his face close to her own. Pain reflected in her violet eyes.

"D-do you need something?" the farmer stuttered.

She roughly released him and shifted away. For a moment, he thought she meant to leave.

"You look like my brother," she answered.

"And? Which one's he?"

"Dead."

"Oh." The farmer's eyebrows knit together. "Well, that's unfortunate."

The War Chief slowly turned to face him. "We lost many great warriors in this fight. Eight. Strong mothers, hardy sons. I failed them. All I can do now is mourn." She looked him in the eye. "Do northerners mourn their dead?"

He chortled. "You're not in the north. You're in Chariv. Property of the Yellow Queen."

"And it is with her your loyalties lie?"

"Anywhere but with that northern caste whore in Sarona."

"Tell me. You are a farmer. Is it so?"

"Yeah."

"And we are in Chariv?"

"Didn't I—"

"And are farmers in Chariv usually thieves?"

His stomach lurched. "Thieves? What—" He paled. Shaking, he looked down. The necklace cord protruded from his pocket. Trembling, he slipped it out and extended it to her. "I—I was—you left it out on the table, I just—I thought I'd have a peek, but—"

She raised her fist. He yelped, covering his head with his arms, before she rested her hand gently on his shoulder.

"My brother. He was a thief, too. That is why he died."

She said nothing for quite some time, just stared at him with her tired, violet eyes. The farmer trembled. Scenes of torture and death flashed before him. Did Ochetski savages believe in mercy? Did they have any kindness in their hearts?

Finally, she sighed. "Just…just keep it. Consider it payment for food and beds. I am sure your ghosts haunt you more than mine." At the door, she hesitated. Just as he expected her to come charging back and throttle him, she shook her head and left.

IGNA. Home to the Rose Fortress, the Red Queen, and more redbloods than the nation had room for. Many things here were red: the heraldry, the granite buildings, and even the sky on some mornings. Red, too, was the Thief's hair: a red like autumn leaves and wine.

Silent, she crept down the corridor of an Upperbirth's lavish manor. She paused to listen at a side door. Content in hearing nothing, she placed her hand on the brass knob and turned. She slipped between the door and jamb, closing it softly behind her.

She spied a table bathed in autumnal moonlight. A thick stack of parchments bound in twine sat atop it, just as she had expected. Some sort of sales records. She stuffed it in her satchel and moved toward the door. As she turned the knob, the thief heard the faintest hint of voices; a woman and a man.

She stood very still. No one was supposed to be home.

The voices quieted again. She suspended her breath. Some whispering. A huff. Words of anger she couldn't quite make out. Something about the mines south of here—the Roseheart Army's greatest source of iron ore.

"I will not have a traitor in my house!" the woman bellowed.

The thief's heart beat in scattered thumps. She let go of the knob.

"That ungrateful bitch is no daughter of mine, Zerhei, I don't care what the law says! I will not tolerate a drop of support for that—"

Her voice cut off. The man's voice was muffled and deep.

"That illegitimate, fanatical—"

The man spoke over her again, too quiet to hear.

"No, no, no, I'll call her what she is—what they

both are! You don't get to tell me—yes. Yes! That Saronan bitch is a caste whore and so is the girl in this house! I want her gone, Zerhei!"

The woman's words burnt the thief's ears. Caste whore. Caste slavery, more like. Those who kept the tradition called them *nezhdoya*; their sole purpose was to marry Upperbirths of other hemotones so those truly born of higher stock didn't have to dilute their precious black blood. In the west, the practice was tradition. In the north, outlawed.

"*Unreasonable*? I'm the one being unreasonable, Zerhei? You're speaking treason and it's *me* that should listen to 'reason'? You know what they did to all the others who refused to—*I don't care*, Zerhei! Yarchala is leaving, and that is *final*!"

Sensing her moment, the thief darted through the threshold and down the corridor, hugging the wall. She stopped at a corner. No movement upstairs, no other noise. Quickly, she shimmied down a short ladder and found her way to the front door. No good. Torchlight leaked through the windows. There were guards outside.

Sweating now, she slithered to the manor's rear. Somewhere in the house, glass shattered against the wall. The thief jumped.

Thudding footsteps marched from one end of the manor to the other. A door slammed. Candlelight splashed across the front door as the man hurried down the stairs. The thief ducked behind a chest of drawers. When he passed, she bolted for the kitchen door. It smacked shut behind her as she quickened her pace across the backyard. Damn the buyer. He'd promised an empty house. There were other hungry minds out there willing to pay for knowledge they shouldn't have. But, the buyer had promised a thousand tadril. The deal was simply too good to pass.

She hastened to the travelmaster's kiosk at the city gates. Her stomach turned. Yarchala. She'd heard that name before, when she lived another life. A faint silhouette burdened her mind's eye. Yarchala. She hadn't known the girl, but a once-dear friend of hers said the name before.

At the kiosk she said one word to the man standing there: "Borrow." He pivoted and rapped three times on the door of the small storeroom behind him. A short, bald man—the buyer—opened it. He looked the thief up and down.

"Let 'er in."

His friend unhooked the rope strung across the kiosk side and waved her forward.

Barrels, bins, and confiscated goods cluttered the storeroom. Such things were picked up by the town watch fortnightly.

The buyer counted out ten shiny silver coins atop a barrelhead. Just those few tenpieces would get her to Sarona. She could start looking for her family and live off the spoils of past jobs she'd been saving. Igna would be nothing but a distant memory.

The thief extended the stack of parchments to him. He snatched them, rifling through each paper with all the grace of a greasy-fingered imp. He nodded and gestured to the coins. She plucked up the first and dropped it in her coin purse. It almost made her feel...guilty. She took the second and third in hand, trying to ignore the disquiet in her heart. Yarchala. What would become of her?

"Are you...you know others like you and I, yes?" she asked him.

"Redheads?"

"No, I mean...aren't you a smuggler? Do you know others?"

"What's it to you?"

She looked at the coins in her hand. No. She couldn't. But… she must. "Do you take jobs?"

"Lady, take your coins and get out of here. I only deal in messes I make."

"It isn't a mess." She bit her lip. "I need a favour."

The buyer guffawed. "Favours? Those are above my paygrade."

"I'll only ask two tenpieces for the papers in exchange. It's eight days to Sarona by cart, isn't it?"

Something shifted in his eyes. He raised a brow. "Now you ain't askin' a favour, you're makin' a deal."

"There's a nezhdoya girl in that house I robbed. Yarchala Sakcha. I heard a woman and her husband arguing while I was in there. The woman wants her gone. I don't know what they're going to do to her, but—"

"And you care...why?" he asked.

Her cheeks flushed. "I don't need to explain myself to you. I don't want her going wherever it is they're sending her. She supports the *Rirah*." Seeing his look, she sighed. "The 'Blue Queen'?" Some had taken to calling her that. He stared back at her. "The 'caste whore' in Sarona?" The words burnt her throat.

"So you're tellin' me it's worth all those *tadril* coins to get this girl to the capital, is what you really want."

She glanced at the barrelhead, then back to him. She nodded.

"Whatever you say, lady. I'll get someone on it soon. When's the deadline?"

"I don't know. Soon, I'd think. Maybe even in the next week."

He let out a low whistle. "Alright. I'll see what I can do, but be prepared for it to fall through. That Sakcha family's not one to mess with lightly. They own those mines the Red Queen gets her ore from."

"I know," the thief said quietly. She set eight coins in his palm. As she turned to leave, she felt his eyes on the back of her neck. She pulled down her cap to cover the marking.

"Oh, I see," he said. "You're one of 'em."

She left without another word. Nezhdoya. Caste whore. Not my own. The thief knew all too well what it meant to be those things. But even if she couldn't save herself, she might be able to save

Yarchala. If she made it to Sarona, they'd return her to her family—her real family, the one that she was stolen from.

She prayed two tenpieces was enough.

III: BOUNTY HUNTER

The bounty hunter knelt beside the man she'd just killed. A blueblood, probably Brisian-born. Alongside him sat a blood-stained folder containing parchments filled to the margins with schematics and notes, all scrawled in High Brisian. Unfortunately, she had not been sent to retrieve drawings annotated in foreign tongues.

She'd made a mess of the hovel looking for the real bounty—emptied all the shelves, boxes, barrels, and bins, and overturned each sack onto the floor. No dice.

No item, no bounty. This time, it wasn't the man her clients were paying her to find. It was some kind of weapon, a new one no one had seen before. According to the client, it was just the thing the Blue Army needed to win the war.

For a moment, she regretted taking this bounty. She was no bloodhound, nor a detective, nor a scout. Finding targets was one thing. They were alive and easily traceable if they weren't smart and one knew how to track them. Objects, however…

She sat on the floor with one leg out and the other folded in, picking at a loose seam on her skirt hem. Maybe all that was required was a change in perspective. Perhaps he'd hidden it in the thatching. That was just about the only place she hadn't searched. She rested her head against the plaster.
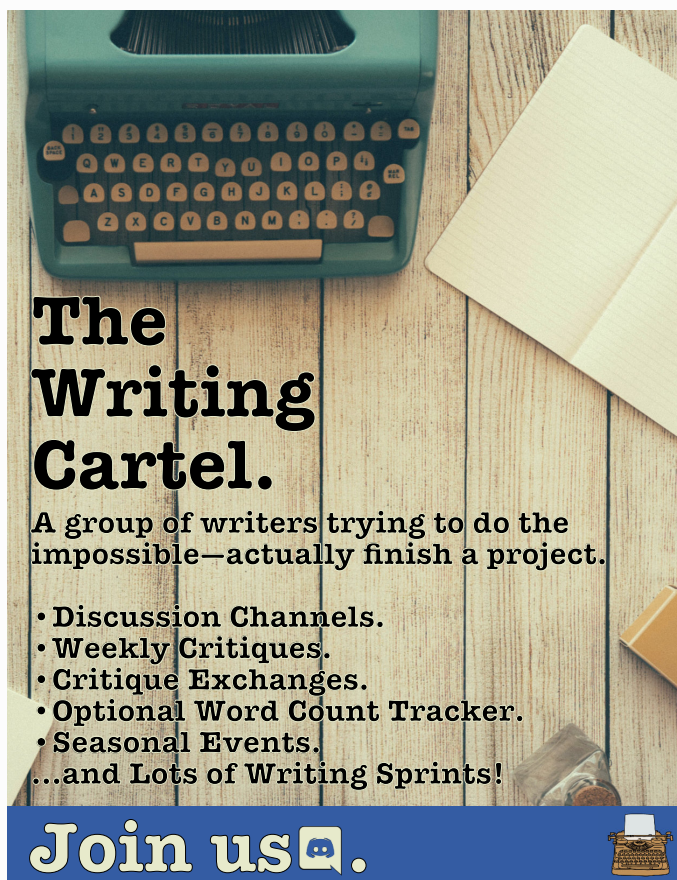
It sank in.

Startled, she twisted around and pressed her hand against it. Thin as paper. Quickly, she unsheathed her dagger and put the tip to the soft spot. It slid through. She sliced upward. The wall split, revealing a deep window well. A pile of wet, mouldy leaves rested at the bottom. Hope and fear on her breath, she reached through, feeling around in the muck until her fingertips grazed something wooden and metal. Trembling, she pulled the object onto her lap. A broad grin spread across her lips.

There might be hope for this civil war yet.

TWO members of the Blue Guard silently led her down a stone corridor. Boughs of cornflowers and mallow ran the length of the walls.

Admittedly, she was curious as to what the Blue Queen looked like. Rumours said she had survived the plague. No one else had. Those afflicted were doomed to rot alive, horribly disfigured until they drew their last breath. Many more rumours told of her beauty—skin kissed by starlight and silvery hair that caught light like opals in the sun. She couldn't help but wonder which was right.

The guards halted just before a wooden door bound by pitted iron. A curtain of ivy cascaded down the walls aside it, meeting two potted plants like summer rain. The tallest guard rapped thrice on the door and opened it.

To her puzzlement, the room was empty. She set down her back-basket, which carried all she had found in the hovel, atop a low table. Her eyes wandered about the lavish setup. More low tables and potted plants, marble vases, mahogany bookcases, carefully placed statuettes. A large desk waited at the back of the room, framed by dark green curtains shrouding the stained glass window.

The door opened. A scarred woman with the clearest blue eyes the bounty hunter had ever seen stepped inside. She let the door close itself.

"Show me," the woman said in a melodic Rendroxjan accent.

The bounty hunter took a step back. This woman had pitch black hair and skin like the deep blue-grey of the ocean. Part of her left ear seemed to be missing. The bounty hunter crossed her arms. "You ain't the client."

"No, but I am here on her behalf."

"No client, no bounty."

The woman produced a sealed note from the folds of her cloak. "Can you read?"

"Of course."

The woman held out the note.

The bounty hunter broke the seal—three cornflowers in blue wax—and read the perfectly-formed script. "A sum of…" Her chin shot up. "Six *hundred* tenpieces?"

"The Rirah rewards loyalty. If I determine that you brought the correct item, you will see every piece of it. Don't worry about the amount. The Rirah deals only in clean money."

The bounty hunter gaped. "What even is this thing? It's worth *that* much? What did I just—"

The woman turned to face her. As their eyes met, the air seemed to chill her very bones. Melancholy gripped her innards and twisted. She sucked air through her teeth. Her vision wavered. When the

woman broke their gaze, the feelings vanished.

"I—" The bounty hunter looked to the letter, the floor, and the woman, searching for an answer she doubted she'd ever find. "Take it, then. Here." She fumbled with the basket straps, undoing them as fast as her fingers allowed. She pulled it out, shoving the parchments into the woman's hands as she heaved the thing up.

It was short, coming up to no more than the middle of her thigh. A long wooden block plated with iron made up its handle, and at the head was mounted a two-stringed bow. Some sort of firing mechanism made up the tail end. If it was meant to shoot arrows, they would have to be short.

The woman paled. "The Rirah sends her thanks," she said, taking the strange machine from the bounty hunter's arms. "You've done Kandrisev a service it will not forget."

"But what *is* it?" the bounty hunter asked.

The woman opened the door and said something to unseen faces. The two guards who had brought her here appeared at the door.

"Take her to the treasury. Let them know property has been purchased and a household cobbled together. Take her to the address they give."

The bounty hunter's eyes widened. "What? Wait, I already have a—"

"I trust you will find your new life comfortable." The woman put the machine and its papers inside the back-basket and hoisted it onto her shoulders.

"Wait, that's my—"

The guards each grabbed one of her arms and led her from the room.

IV: STEWARD

DAWN had just broken the horizon, but one wouldn't know it from the musty, windowless depths of Saltwater Keep's kitchens. Bleary-eyed, the steward monitored the new hire working quietly to fillet the pile of salmon atop his workstation—a very new hire, as today marked his first shift. He was a young boy with earlobes still crusted with blood from the metal rings punched through them on his fifteenth birthday. He sliced quickly, setting the fillets in a pan filled with brine as he finished each fish.

The steward cleared his throat. "You there. With the fish."

"Aye, sir?"

"You aren't from here, are you?"

"No, sir," the new hire said.

"Where, then?"

"Sosna Chonok."

The steward considered his response. Most fresh blood that came in through the kitchens was Nilovan, born and bred. Curiosity as to the circumstances of his arrival piqued the steward's interest. "What city?"

"Sarona, sir."

"Ah, the capital." The steward smiled. Perhaps he'd be an even better worker than Nilovans. "Loyal to the Rirah, then?"

The new hire paled, but he didn't stop working. As he flopped another half of salmon into the pan, he cast the steward a sidelong glance.

The steward slowly walked around the table to stand at his side. He paused, simply observing the new hire's harried work. "Nilova is loyal to the Rirah," he said. "It matters not to me personally as to whether or not you support her in your own head, but I wouldn't let the words slip from your mouth or you may end up in a position of stress."

The new hire nodded. "Aye, sir. I am loyal. It's just…" his voice shook. He pulled another fish onto the table. "Well, folks are callin' her the Blue Queen now, amongst other things. Rirah's turned into a dirty word up north, what with three other women claimin' the title for themselves. Most folks don't know who to believe."

"She inherited the Candrish throne from her elder sisters and their mother before them. She is the Rirah, regardless of what the other three claim."

"That's...not what most folks are sayin' is the matter."

The steward raised an eyebrow. "I think if anyone is suited to ruling alone, it is none other than your 'Blue Queen.' She's a woman of great strength and faith. Certainly the most promising leader we've had since her mother Ïnna the Great, Seamstress guide her shattered soul." He moved away from the table, hands behind his back. "Why, the gods saw fit to give her the gift of Shardsight. If such a blessing isn't a divine remark on her suitability, I couldn't tell you what is."

"That's...also not it."

"Well then, what *is* 'it'?"

"She's nezhdoya."

The steward pressed his lips into a thin line. "Careful now, boy. You're treading dangerous waters." He glanced to the door, then turned to face the boy. "But you may continue. What bearing does being nezhdoya have to do with her right to rule?"

The new hire looked as if he was going to be sick. "So...that makes it so she ain't really a Ranov." He quickly added, "Some folk say she's a lowbirth in Upperbirth's clothes. Lots are callin' her a caste whor—"

"Bite your tongue, whelp," the steward commanded. "She's a Ranov by the very laws those warmongering traitors in the West hope to reinstate, and that's that."

"But she married a redblood. What's more, a lowborn redblood. Her own bodyguard. She should—"

"Have done just that. That's what nezhdoya were chosen to do, before she struck down the law. Marry into other blood colours so your 'real' Ranovs of the world don't have to muddy their own. She's a blackblood through and through, regardless if her birth mother was no Upperbirth."

The new hire spoke quietly. "I like the Blue Queen. She's done a lot for Kandrisev, starting with the nezhdoya ban. I'm grateful for it even. My baby brother was chosen to be one before she came into the crown. He only knows me because of her orders for them to go back to their real families. But this war…"

"The Rirah did not start this war. The traitors Elgana Yolkerev and Magya Odov did."

Sighing, the new hire stuffed his hands into another bucket underneath the table. "Let's just get back to the fish."

The steward snorted. "That's how we got into this mess: 'just getting back to the fish.' Listen well, boy, the death of an ocean lives in the silence of fish. When Chedevrena and Nelavnï Ranov stood up to Yarpok the Usurper, do you think they could have acquired such massive legions for their revolt if not for the uprisings of fish?"

"Well, it ain't like you or I can do anything about it, so we may as well."

"Not individually, no, but together…" The steward raised a finger to the ceiling. "Those first Ranovs walked these very streets, fished in these same waters, and were the mothers of this modern era. They put an end to Yarpok's tyranny with no more knowledge of tactics or rebellions than you have because *they believed they must do it*. Just like we *must* and *will* depose the traitors in this war."

"Well, they didn't have the Rosehearts *and* the Yellow Army to contend with, not to mention Ochetski war parties goin' on raids all the time."

A moment of silence passed. The steward's next question was dangerous, especially if any eavesdroppers were about. He leaned in across the table until the new hire's breath warmed his nose. "You tell me, boy. Do you believe the Rirah will win this war?"

"I don't think she *can*," he replied, voice barely above a whisper. "There's two armies for her to fight and she's got the smallest one. They've teamed up against her now. That's too many enemies."

"And too many non-believers like *you*." The steward shook his head. "Finish sorting those fish, boy. I'll be back with someone to relieve you at midday." 🪐
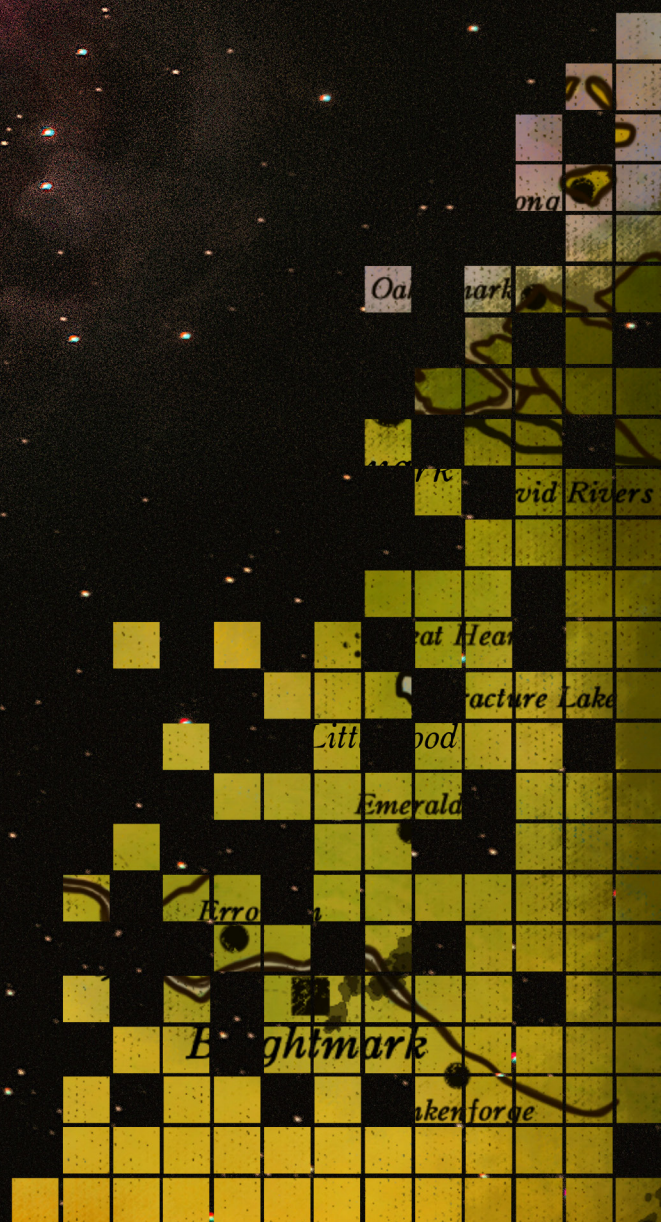
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BUILDING NUMERICAL RELATIONSHIPS IN WORLDS

By Psycho Romeo
Art by deificat

THEORY & ANALYSIS 💡

When worldbuilding, we often find ourselves having to think about how some concept or event will pan out within the established rules of our world. If we're lucky, we can draw inspiration from the real world to answer these questions. Other times, we may be deep in the realm of fiction with nary a paddle nor ion thruster to guide us. So, how would we evaluate questions such as the following?

• With a population of 3000, how large must a fully-sustainable space station be?
• How much more advanced will the average consumer flying car be in 50 years?
• Between the Baguette Brotherhood and the Cornbread Conglomerate, who would win an all-out war?

In my math classes of elementary school, one of my favorite methods of evaluating problems was to simply guess and check. Spitballing an answer and then seeing how it measures up is a very fast way to complete a word problem or simple algebra. However, as I moved through high school and college, my math courses became more complex. The numerical relationships in word problems became less linear, and staring at the question and guessing was no longer an efficient use of time. The takeaway from this paragraph is that the more moving parts a particular scenario has, the harder it becomes to guess its result. When it comes to worldbuilding, one can find that their world has a lot of moving parts.

The best way to deal with this, in my experience, is to assign numerical values to the fundamental parts of these concepts. By breaking our scenario down into smaller, more digestible building blocks, we can begin to create and extrapolate on patterns and create a believable result. This is the same process that's used in creation and balancing in game development. There is still some guesswork, but it's highly-educated guesswork. In this article, we will utilize such strategies and techniques to divine the answers to the earlier mentioned questions while exploring the topic of **building numerical relationships**.

When looking up "extrapolation," we get a definition that more or less says, "*n*. A calculation of an estimate of the value of some function outside the range of known values." The ability for us to extrapolate comes from our ability recognize patterns. In the real world, this is easy—gravity will affect all things in the same way, so we can guess with high accuracy what will happen if an uncooked egg rolls off the kitchen table. However, in fiction, we are often called upon to be the architects of the events that transpire in our world. We can either inform the consumer of our world what happens as they happen, or we can show them the patterns and rules that govern our world. Today, we will be doing the latter.
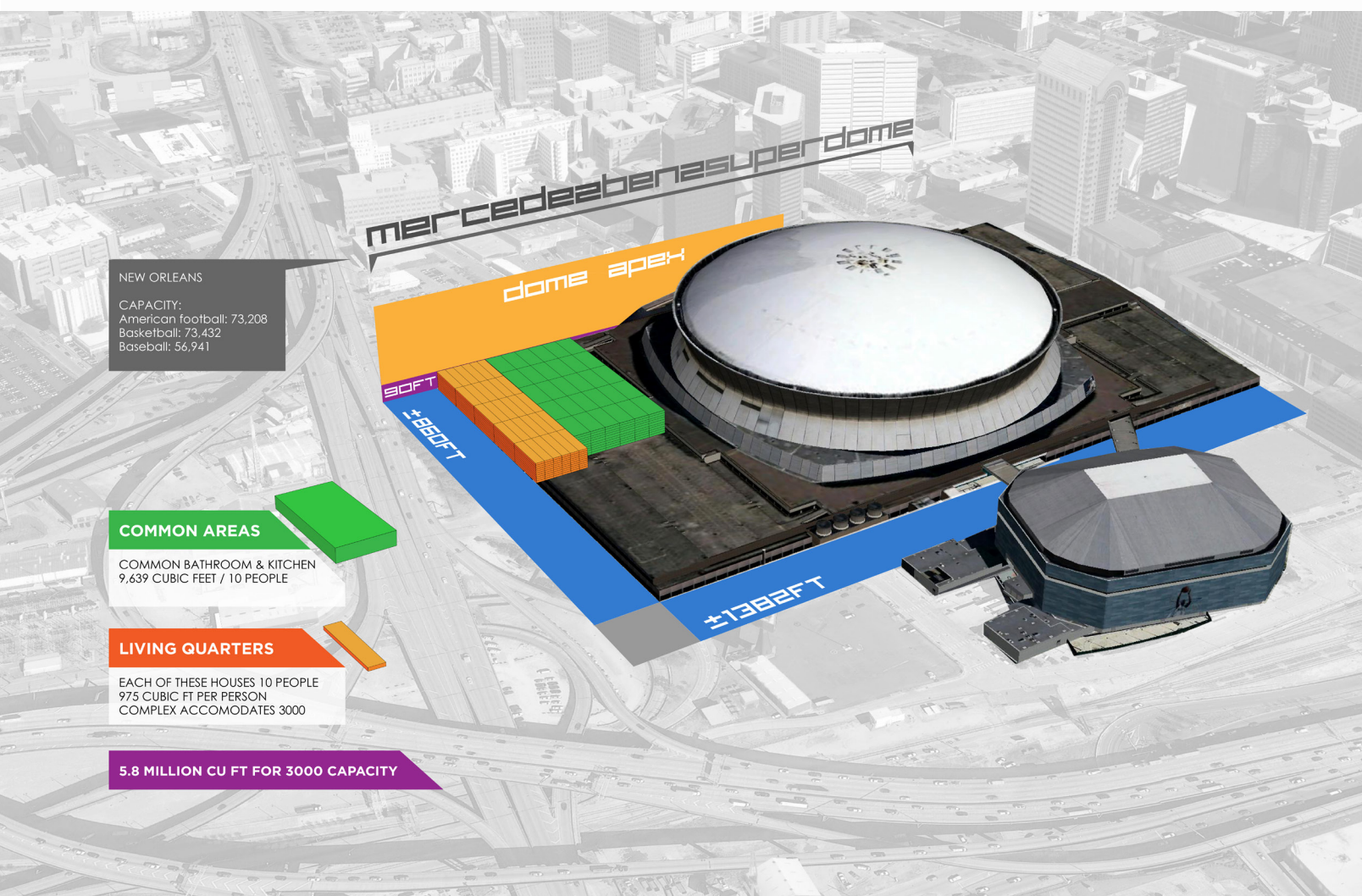
GREAT, BUT HOW DO PATTERNS TRANSLATE INTO SPACE STATIONS?

The question, "Given a population of 3 million, how large would a fully sustainable space station need to be?", may seem daunting to think about at first, but this can be fully broken down into simple math. Every worldbuilder has the capacity to pull out a calculator and do multiplication. Firstly, this question lacks a lot of context that would normally be supplanted by the world you're asking this question in. For example, maybe in your world, you're talking about a military station where comfort is second to efficiency. This might end up being a lot more compact than a space station full of luxury hotel suites. Or maybe your world will need wheat farms and must devote more of a station's real estate

than a world in which stations can print food out of hyper-growth soylent algae. So to start, we'll establish ground rules and begin building upon it block-by-block from there:

The average person will live in a dormitory-style space, consisting of a 6'x8'x8' bedroom and a 6'x6'x8' foot foyer. We'll add one foot in each dimension for walls and piping, resolving to 975 cubic feet per person.[1]

A communal bathroom will be 20'x40'x8', and a communal kitchen will be 10'x20'x8'. This will facilitate the needs of 10 people. With an extra foot in each direction for walls and such, this totals to 9,639 cubic feet per 10 people.[2]

mercedeabenzsuperdome

dome apex

NEW ORLEANS

CAPACITY:
American football: 73,208
Basketball: 73,432
Baseball: 56,941

90FT

±860FT

±1382FT

COMMON AREAS

COMMON BATHROOM & KITCHEN
9,639 CUBIC FEET / 10 PEOPLE

LIVING QUARTERS

EACH OF THESE HOUSES 10 PEOPLE
975 CUBIC FT PER PERSON
COMPLEX ACCOMODATES 3000

5.8 MILLION CU FT FOR 3000 CAPACITY

[1] A 6' wide, 8' deep, 8' tall room placed behind (along the depth axis, since they're the same width) a 6' wide, 6' deep, 8' tall room, comes out to 6' wide, 14' deep, 8' tall room. Adding one foot in all directions would make it 7' wide, 15' deep, 9' tall, totaling 975 cubic feet.

[2] A 20' wide, 40' deep, 8' tall room placed behind (along the depth axis, since they're the same width) a 20' wide, 10' deep, 8' tall room becomes 20' wide, 50' deep, 8' tall. With an extra foot in each direction, this becomes 21'x51'x9', totaling 9,639 cubic feet.

Combining the living spaces of 10 people with one set of communal facilities, we come to a grand total of 19,389 cubic feet per 10 people.

I got the above dimensions by running around my house with a tape measure and deciding what would be a comfortable (but compact) space to live in. To put this 19,389 cubic feet figure in perspective, this is about the size of a modest two-story house with four bedrooms, three bathrooms, and a two-port car garage. We can now use this value as the baseline building block of our station. A station population of 3000 would need 300 of these residential blocks, totalling close to 5.8 million cubic feet. This is about 1/25th the cubic footage a football stadium (and the lots surrounding) occupies.

But, we didn't just want to know the cubic footage of the living space. We wanted a fully-sustainable station. First, we must define what "fully sustainable" entails. We can then use the same process of calculating building size and just add it to our total of 5.8 million cubic feet.

How much food is consumed per person? How large do the food production and processing facilities need to be to accommodate this?

What is the average amount of waste produced per person? What is the size of the storage and processing facilities required to manage this?

Are there commercial districts, public recreation areas, or administrative buildings? What about areas for engineering, electrical equipment, and life support?

These questions are much more subjective to the world you're building than something like living space, so we won't get into the specifics here. Let's say that our station's infrastructure and living spaces totals to 15 million cubic feet. It's reasonable to assume that all of these buildings aren't going to be adjacent to each other and that we'll also have things like roads and hallways. However, to calculate the volume of roads within our station, we'd need to basically plan it out completely. Instead of going through that trouble, we'll simply create a numerical relationship between our building spaces and our road spaces.

In the example above of an industrial park, we see that the road space between buildings is approximately 20% of the total area's footprint. Assuming our space station has the same numerical relationship of footprint to road as this image, we can estimate that the inclusion of road and commuting infrastructure will bring our station's final cubic footage to 18 million. Give or take a few million feet, I think we have a sufficient ballpark figure of how large our station will be!

WHAT ABOUT SOMETHING MORE ABSTRACT LIKE FLYING CAR TECHNOLOGY?

Dealing with numbers is easy—we have tools, calculators, and textbooks that tell us how numbers behave and interact with one another, and we never have to wonder too long about how these things will pan out. However, as we become more abstract, we have fewer and fewer numbers to base things off of. To answer the question of "How much more advanced will the average consumer flying car be in 50 years?", we'll need to start assigning some values to the moving parts in our question. Much like our space station example, after we define values to the fundamental elements of our scenario, we'll build upon it block by block until we get to our end result. However, like with the roads element of that process, we'll need to identify numerical relationships between some of the more abstract elements of our flying cars.

Before we begin, let's talk more about using numerical relationships. To help us evaluate the numbers involved with flying cars, we'll take a look at how games evaluate the numbers in systems, such as combat mechanics, point scoring values, or upgrading/buying costs. Games also have a lot of moving parts and very rarely do they have the luxury to draw numerical inspiration from real life. There is a very methodical and organized approach to finding mathematically sound numbers for a game while using as little guesswork as possible. Say for instance, we want to determine numbers for the lowest level enemy and equipment in the game. It involves the following core steps:

Establish a value of a baseline event. For example, "It will take 6 seconds to kill a basic slime using a basic weapon."

Identify another event and how it measures up to our baseline event. For example, "Red slimes will take one and a half times as long to kill as a basic slime."

Solve for x. "One and a half times 6 is 9, so red slimes will take 9 seconds to kill with the basic weapon."

This method becomes powerful as we repeat steps 2 and 3 to layer in more complexity into the game. For example, we can identify the bronze sword as an item that will reduce the time it takes to kill a basic slime by half. This means that a basic slime takes 3 seconds to kill using a bronze sword. Since we've identified a red slime's numerical relationship with basic slime as taking one and a half times

as long to kill, we also can solve how long it will take to kill a red slime with a bronze sword: 4.5 seconds. It's important to remember that when we solve, we generally always measure things up against our established baseline. We could easily say "if a bronze sword reduces the time to kill by half and red slimes take one and a half times longer than a green slime, they cancel out." But this solves to 6 seconds, which is incorrect! Trying to take shortcuts like this may cause less headaches now but will cause more headaches down the road.

I've come to call this the Time To Kill (TTK) method of game balancing, as using "how long it takes to kill something" serves as a pretty universally understood concept when explaining it. However, the value established does not have to be a unit of time. It can be turns, attacks, ammunition, money, workers, or whatever standard unit of measurement would be fitting for your world. You can even invent values, which we'll start doing here. For our example with flying cars, we'll establish a value called Tech Level. We'll identify the numerical relationship between Tech Level and Speed, project Tech Level 50 years into the future, then solve that relationship again to find what our new Speed will be.

First, let's establish some context. Today, in our world, flying cars can go 200 mph which we'll establish at a Tech Level of 120. Next, we'll identify some relationships between these numbers then solve for the result. We'll identify Tech Level as increasing at a rate of 0.5% per year. This solves to 120.6 in the first year, 121.2 in the second year, and so on and so forth until we get to about 154 in year 50.

Numerical Relationship	Year+0 (TL = 120)	Year+50 (TL = 154)	Year+100 (TL = 197.6)
Tech Level*1.666	Speed = 200.0	Speed = 256.6	Speed = 329.3
56+Tech Level*1.2	Speed = 200.0	Speed = 240.8	Speed = 293.1
105.5+(Tech Level)0.95	Speed = 200.0	Speed = 225.2	Speed = 257.2

Now, we can identify the relationship between Tech Level and Speed. It would be easy to say that Speed is 1.666 times the Tech Level (TL) as 120 * 1.667 = 200, however that puts Speed at 256.6 by year+50. This doesn't sound so bad at year+50, but if we project to year+100, we come to a Tech Level of 197.6 and a Speed of 329.3. If this looks good to you, then great! We're done. But maybe we think that this value is growing too quickly for what we want it to do in our world. We can more carefully reconsider Speed's relationship Tech Level, and instead give it some more time.

After solving for the various scenarios above, we have a variety of mathematical formulae to pick from as our numerical relationship. I might like the third option the best since I may be building a world that spans a long period of time, and I don't want things to change too much over the course of my story. But you may have a different goal with your world, so pick the one that works for you!

NO MATTER HOW I RUN THE NUMBERS, THE WRONG SIDE KEEPS WINNING THE WAR!

Well, then clearly they're supposed to! Sometimes, we approach a worldbuilding scenario with an end result already in mind. Just because the numbers don't pan out towards our goal doesn't mean that our goal is wrong; it means we must bring in creative elements to tip the scales in our favor. This is one of my favorite parts about employing numerical relationships in worldbuilding, as they can serve as an excellent tool to guide and inspire our creative process. Let's consider the scenario:

"Between the Baguette Brotherhood and the Cornbread Conglomerate, who would win an all out war?"

Like our previous example with the flying car, I would approach this by breaking down 'war' into more abstract fundamental elements such as Supplies, Tactics, and military Might to represent things such as resources, advantageous base placement and response time, and weaponry. These values would have a numerical relationship with an overall value called War Factor, which I would solve for and compare at regular intervals. The winner in each comparison might have their values for Supplies, Tactics, and Might reduced by a small amount, and the loser reduced by a lot, all depending on a number of factors we won't dive into for this example. Maybe this war would take place over many years, and I can compare War Factor each year and see who bottoms out of everything first. Perhaps each faction has an income of the various war elements based on some of the events happening within that faction's territories.

We've looked at enough numbers so we won't get into the specifics, but let's say that, try as we might, we simply can't find a realistic set of numerical relationships where the Cornbread Conglomerate comes out on top. Yet for our grand story to make sense, they really do need to take over and beat the Baguette Brotherhood. Let's say that our War Factor pans out like this over 4 years:

Year	Baguette Brotherhood War Factor	Cornbread Conglomerate War Factor
1	1498	1280
2	1192	926
3	827	739
4	607	422

In year 3, it looks like the battle was actually very close—Cornbread Conglomerate was only 34 points under in War Factor. This would be a great place to employ some creative writing:

The Cornbread Conglomerate's situation was becoming more dire with each passing moment. The impending battle over the fringe planet of Noble Butters would not be one that the Conglomerate could win; however, ceding the fringe worlds without some form of contest would bring morale to the breaking point and sow the seeds of defeat. Strategists toiled in their briefing rooms for days before coming up with a plan. The Baguette Brotherhood was sorely lacking in supplies this far away from the core worlds but had no shortage of military bases to use as staging areas for transports. The Conglomerate would exploit this by sabotaging a large amount of supplies and running it dangerously close to Brotherhood territory. After the battle was lost and the supplies captured, they would be distributed to Brotherhood military bases and, at the predetermined time, violently explode, rendering the bases inoperable.

A ploy like this could have a direct effect on the values we use to determine War Factor. Perhaps the Brotherhood's military base presence was inflating their Tactics score and therefore War Factor. A sacrifice to the Conglomerate's Supplies score to damage the enemy in this way may tip War Factor in Conglomerate's favor, allowing them to mathematically win the war.

MATH AND WORLDBUILDING TOGETHER?

Many worldbuilders are writers who can weave together theatrical plots out of historical events and encyclopedia entries. This is an incredible and admirable skill to have, but I would encourage all worldbuilders to try and incorporate functional elements and events driven by numerical relationships into the stories they create. If nitty gritty math is intimidating, start with smaller numbers and concepts that are easier to abstract, such as "emphasis one faction puts on trade relative to another" or "number of ships a port can comfortably field." Just as it's easy to get lost in the details of a particular event or story, it's also easy to get lost in the numerical relationships in parts of your world!

LET TECHNOLOGY LIMIT YOUR FANTASY WORLD

Maciej Aureus Gajzlerowicz
Art by Anna Hannon

I keep thinking about fantasy realms that nullify their technological shortcomings with magic. You've probably encountered many examples already. Here is a good one: mobile phones replaced with telepathy or enchanted mirrors, so your characters can stay in touch even if you sent one of them to another continent three hundred pages ago. And sure, lower classes might not have access to such high-level spells, but since the majority of heroes in fiction work with or fight against characters with significant wealth or power, this unique ability has become a fantasy cliché.

Supernatural gadgets and powers are convenient shortcuts that solve complex issues without exhaustive explanations. Thanks to magic, you can swim underwater for half an hour, have a cozy room with an eternal fireplace that needs no fuel, or brew a potion that disallows another person to lie. Basically, you can push the plot forward with no need for logic. When used sporadically, these shortcuts build the sensation of wonder and mystery. When overused, they put your world's rules into question—no matter what they are. When so many exceptions exist, it may feel as though the rules can be bypassed whenever it's convenient. I call this method "because magic," and I sort of hate it. You know how it works: the heroes approach the villain's inner sanctum after covertly infiltrating their stronghold. Suddenly, the doors slam shut as they pass through a room, and a sinister voice taunts their efforts. How did the villain find them? They covered all their tracks!—"Um…Because magic."

For some settings, replacing advanced technologies with magical powers and creative trinkets is a core part of their identity. Two successful examples instantly come to mind. *Discworld* uses magic to make fun of modern technologies, such as newspapers, movies, or supermarkets. When Terry Pratchett replaces a camera with a tiny demon that's locked inside a wooden box, furiously painting on canvas, it's a joke in itself. It creates the possibility of further light-hearted situations, such as dialogues with the aforementioned demon-painter, and adds to the grander lore of the setting. On the other hand, the society of British wizards portrayed in *Harry Potter* turns a school of magic into a relatable background used to portray challenges of childhood. When J. K. Rowling describes all the expectations and stress that teens experience during teleportation lessons, it's not just another adventure put in front of the characters. It's a direct reference to all the trials that many kids face while trying to get their driver's license.

Sure, these tools are not always perfectly executed and we can run into a bit of *deus ex machina*, but they usually have a larger purpose behind them. The "because magic" approach, on the other hand, is often meant to make things simpler for the characters and, by extension, for the writer; even though it may put into question the internal logic of the setting. Maybe you've heard the classic problem of resurrection spells introduced in tabletop *Dungeons & Dragons* games. They allow players to have another chance if they lose their character after playing it for dozens to hundreds of hours. But there still would be quests such as "a king was murdered, we need to investigate." Why investigate if you can resurrect him and ask him who did it? Some Dungeon Masters and writers could answer this question, for example, by introducing daggers capable of destroying human souls. Depending on the rules and tone of the setting, there is nothing wrong with this approach. Perhaps magic intentionally serves as a tool to move the plot forward or bypass logic. But, over-reliance on spells and magic makes your world's reality less concrete. Thoughtful planning not dependent on "because magic" can create an immersive, believable, and perhaps more serious setting because the reader understands the rules of the world by drawing on their real-life knowledge and expectations.

I think the limitations of less advanced technologies are not something that we should always fight with or run away from. They can be embraced. Technological limits add a creative spark to our worlds by forcing us to figure out how fictional societies deal with these shortcomings or how they live with them if they can't be fixed.

Let's assume that the quest giver won't give our team a "because magic" crystal that allows them to have a conversation whenever it's necessary. Now we have to think of what the characters would do in this position. Basically, we're taking away their mobile phones.

Imagine a group of travelers who are very aware that a bad decision may end their lives. Would they decide that the job is too dangerous and do something safer instead, even if less rewarding? Would they have to figure out a plan B or plan C, just in case they become separated? Would they be ready to let a prisoner go without double-checking if the received intel is accurate? Would they be ready to travel to a distant island, knowing that for over a month they would lose any contact with the outside world?

Or, let's assume that our fantasy realm has never locked any sound in a stone pillar of "because magic," so there are no thousand-year-old "voice messages" with built-in lore exposition inside a dungeon. Now we have to add more non-obvious environmental worldbuilding to the ruins or describe how the characters slowly figure out what this place is, including how they can solve ancient puzzles to find what they're looking for.

Focusing on rational, well-researched solutions takes more effort. If a village is protected by a "because magic" barrier cast by a druid, you don't

need to read about walls, palisades, or moats. If people have "because magic" crystal lamps in their homes, we don't need to type "how were candles made" in Google. If you have "because magic" goats that produce a plenitude of delicious milk, you don't have to ask yourself what conditions keep such animals healthy. A "because magic" library doesn't need to be built in a way that would keep the books safe from rotting...

Very often, worldbuilders try to make their settings feel alive by borrowing solutions from other games or novels. However, researching helpful information and finding ideas help worldbuilders portray their characters as creatures who are a part of their world and who know more about the things that surround them than the reader or player. It's almost funny how often you can find fictional meads or wines described with three distinguishing features: how expensive they are, where they come from, and whether they are "rare and vintage." It only takes a couple of minutes online to see how much more you can tell about these beverages: the landscape required to create them, if the mead uses yeast or human saliva, or if they come from a society advanced enough to even have a commonly used calendar and an upper class capable of knowing what "1251, Placeux" means.

Modern people living in richer countries are usually accustomed to having access to all the goods they need. If there's something they don't own, they are only limited by money, not by the availability of the goods themselves. On the other hand, in fantasy realms, especially those that are struggling with wars or poverty, your travelers may keep finding new, unique places which have to live without some classic fantasy amenities.

Maybe not every village will have access to beers, and many types of beer won't use hops as the core spice, resulting in a large range of tastes and recipes—not only piss-like and good "grades."

Some villages might not be able to produce bread or breed cattle, so they won't offer some popular meals in their inns. Without access to animal skins or flax, cloth production will be limited and may result in some creative ways of making garments look prettier. Towns don't always have to be put on top of "because magic" elven ruins or hilariously large sewers. Maybe there just is no underground passage leading to a locked treasure, so this time, you won't be able to add a heist scene solely based on the absolute incompetence and obliviousness of the guards.

I keep thinking that less interesting magic tricks that push the plot forward and glue together otherwise unattached parts of the setting are very often related to the "don't overthink it, it's just a book" approach. I believe we can do better. Introduce logic to our worlds and reason to our stories. Let magic do the things it does best—portray a realm beyond our senses. Sometimes magic can be a colorful set of questions or a series of problems to overcome, rather than a simple "because magic" set of answers.

If you allow your world to be limited by its own technology, instead of finding ways to imitate our reality, you will also allow your realm to develop more identity. By deciding how a specific area is limited by the brutal reality you attached to it, you'll help yourself portray various places as distinctive and born from thought-out planning.

Researching topics for inspiration is one thing, but using your research to your advantage is a different beast. It may, for example, pressure you into taking a closer look at some fantasy clichés that you have introduced in your projects. Even if some new ideas don't match what you are more passionate about, you may be surprised by the grand results of challenging yourself and putting effort into understanding your world's technology. In other words, stay cohesive with the rules you previously invented. 🪐

My name is Matthew Myslinski, and I am a dark fantasy painter, writer, and game developer from Arizona. Throughout my life, I've been interested in creating and building worlds, and what started on loose-leaf paper and napkins at the dinner table lead to what I do today. I've done work for comics, fantasy book covers, roleplaying game interior artwork, and concept art for video games, all of which were digital. A year and a half ago, I left my day job and went freelance. This allowed me to work on my dark fantasy worldbuilding project, Driftwood Archives, with the rest of my time. My world of Driftwood Archives is designed to be more than one element; it is intended to be a setting in which roleplaying games can be played, readers can dive into short stories, fans can get lost in the artwork, and a number of other mediums that are close to my heart.

I am primarily a digital artist using Photoshop and a Cintiq tablet. My process varies, with either an idea or the artwork coming first, and then the rest coming in after. Sometimes I have an idea that needs to be illustrated, and for others, the reverse happens. It usually flips back and forth a few times before I decide on nailing something down for sure (hence the importance of sketching and concept art). I draw inspiration for my work from folklore, mythology, popular sci-fi and fantasy tv shows, video games, and books, among other sources like Dungeons & Dragons and Magic: The Gathering. I enjoy taking tropes and commonly overused concepts and turning them over into something new, utilizing grey character building and art-driven concepts. The only conflicts I run into when doing this kind of a project is how often I change my mind about some things and how long it actually takes to build a world this size.

My main goal when I'm working on this project is to create something I enjoy. Beyond that, I want to inspire people. I want people to see my work and be so amped up to either read more, dive in and play in this world I'm creating, or go out and make their own world. I want people to be happy, excited, and fall in love with my setting and characters.

So far, I've seen a lot of good reactions and positive feedback, and while some may make its way into future iterations of the world, it is primarily the world I want to read and play games in. Hopefully, others will feel the same way.

If you are an aspiring artist or worldbuilder, remember this: nothing truly worthwhile ever comes easily. Or commonly. Rome wasn't built in a day. Game of Thrones, Lord of the Rings, Harry Potter, The Witcher.... none of these would exist if their authors gave up along the way. Decide whether worldbuilding and creating similar works is a hobby or a career. If it's a hobby, have fun. Do it however you want and do it for yourself. But if you are trying to make a career out of worldbuilding, whether for a novel or games or a tv show... it will be a labor of love. You will experience long days with little reward for a while. It's a lot of wanting to work on your world while having to do other things to pay the bills, slowing your progress down. And that sucks. But no matter how long it takes or who tells you that you can't do this, never give up. 🪐

For more information about Driftwood Archives or to commission Matthew for personal/commercial work, please visit https://www.matthewmyslinski.com/ or email him at matthew@driftwoodarchives.com. You can also catch Matt painting live on Twitch most weeknights at www.twitch.tv/MatthewMyslinskiArt.

This interview was edited for Worldbuilding Magazine.

Special thanks To Matthew for taking the time to speak with us and share a few pieces. You can keep up with him and look at more of his work via the channels mentioned above. If you have an illustrated world of your own, apply for one of our future art features.

FANTASTIC TECHNOLOGY:
INCORPORATING TECHNOLOGY INTO YOUR FANTASY WORLD

by Tina Hunter

So, you have decided to build a fantasy world. Something with dragons, perhaps? A sweeping, epic tale? But there will definitely be magic, so how can you incorporate science and technology believably? Many people focus so much on the magic in their fantasy worlds that they forget that magic and technology can coexist. Any well-built fantasy world will have some measure of both.

To be fair, there are different levels of magic in fantasy. For this article, I'll be focusing on worlds that use a hard magic system—systems that have specific rules surrounding magical use, costs, and limitations. There are also different interpretations of technology and science. I'll refer to technology as the man-made tools and objects that we use to make our lives easier and science as anything that utilizes a specialized knowledge of the world around us.

First, let's look at what kind of impact technology can have. The saying, "necessity is the mother of invention," applies to all worlds and especially to the development of technologies.

A CASE FOR TECHNOLOGY IN FANTASY

Why develop a gun when you can just shoot a fireball from your hand?

Well, how does one magically create a fireball? How long does it take to make it? What if only some people can manipulate fire? Magic must have limitations to allow for conflict, which in turn makes for more interesting stories. So it would make sense to develop technologies that could equal or even surpass magic. Technology can give magic-like powers to those not capable of magic. Unless the magic in your world is both common and cheap, there will always be someone who can't shoot a fireball out of their hand.

In the 12th century, the Chinese used bombs called "fire cannons." It was basically just a fireball shot out of a tube of bamboo, though it only traveled a short distance. Metal cannons that shot arrows or stone balls made their way onto the battlefields by the 13th century. Imagine if the Chinese had fought against magic users. How fast might guns have developed if non-magic folk had to fight against those with magical abilities? The need to defend yourself from magic would be a large incentive to speed up the development of technologies.

However, technological change doesn't need to happen quickly to be profound. We perceive technological advances today very differently from two hundred years ago. Advancements happen so quickly now that your great-grandfather's life involved a very different level of technology than your own. Change any slower than that isn't really perceived as a change in retrospect, but for people at the time changes still happened. You control the effect a piece of technology has on your world, partly by placing your story in different stages of that technology's development.

Remember our "fire cannon"? Gunpowder was a side result in the search for longevity-increasing drugs by Taoist alchemists. That alone tells you that during its early years they were merely trying to find a good use for the "fire medicine." While it went on to change the face of warfare, it did little to influence the day-to-day life of the average person. There would be more jobs in the growing industry, and it would become part of the cultural story, but there was no real cultural shift required for its use.

On the other hand, the printing press was a technology created around the 8th century that would later create a massive cultural shift within

different societies. By the 13th century, China's printing press improved the speed of communication and disseminated information to commoners. The same happened in Europe roughly 200 years later. Books became prevalent in society and helped create a class of educated citizens. Meanwhile, collections of printed books became a status symbol for the wealthy. The printing press influenced every aspect of society, from education to status.

Technology and science can influence the immediate culture of your story, or it can be used as a tool to build the backdrop of your world. It's your job as the author to figure out which one will give your readers the most enjoyable story. Even without books, science, at its core, is the careful study of the world. A wizard who creates potions would have to study the effects of certain plants to know which work the best. A scholar of dragon lore would have to study dragons to be able to tell the difference between a dragon's breath attack versus a roar of pleasure. Once we understand how something works, we can create technology which exploits that understanding. You can study magic the same way you would study botany, animals, or chemistry. And just because "magic is magic" doesn't mean that it is inherently more interesting to study than some other topic. Intense study leads to breakthroughs in both magic and technology. Humans have investigated the underlying patterns of the universe for millennia, so it would only make sense to still do that even if there was magic in our world.

KINDS OF TECHNOLOGY

There are entire sub-genres dedicated to worlds where magic and science coexist. Urban fantasy is most commonly associated with the idea since it is set in the modern world with a dash of magic. However, there is a broad umbrella of science fantasy subgenres which try to blend science fiction and fantasy together. Even if you prefer to set your story in a more traditional fantasy world, technology can play a vital and important role.

Technology has to fulfill a purpose in your world and, more importantly, your story. Your magic system may come first since this is fantasy. Once you have a base, look at your marvelous magic system and identify the holes magic can't fill in your world's

societies or cultures. Perhaps technology can. When people need something they will use the easiest method to get it, we're just lazy like that. So, if only some people can use magic, or magic has a very high cost, us lazy humans will try to find another way to get what we need. If the magic fulfills the need, then the demand for technology goes away. At least, for most people. Remember to look for conflict.

Imagine someone who lives in a vast country and magic has no real means of transporting you anywhere faster than you could walk. Perhaps there is a way to transport things with magic, but it requires the use of a dragon's heart and is highly experimental. For some people this isn't a problem, but for others it might be. Enter technology. If people need better transportation, then perhaps they will end up with steamships before cannons. An arms race between technology and magic to fill certain needs may be an interesting conflict to explore in your world.

Specialized technology could come out of a world with constant stressors on its population. These stressors could include wars, the need for food, or highly coveted resources. Making lives more comfortable would be addressed next. A farmer could be thrilled at his new tractors and harvesting equipment, but I doubt the little boy eating a sandwich in the city cares how the wheat for his bread was harvested. If magic can't do it, technology eventually will, but it's up to you to decide your story's focus.

YOUR TURN

Magic and technology can blend together really well, with each filling in gaps that the other cannot handle. Let's go through some questions you can ask yourself to see if adding technology to your story would be a good thing.

The first and most important one to ask is: *Does this technology add or create tension/conflict in my story?* If yes, then go ahead and add it. If not, you may want to rethink why you want to include it. Add technology that makes your world vibrant and complex, not just because it's cool.

If your world has gods, do they approve of this technology? The answer will depend on the kinds of gods. They tend to like having control over certain aspects of your world, and any technology that interferes with those aspects may not be approved of. Unless you have a god that likes to tinker and thinks a flying mechanical horse would be a great gift.

How would this technology affect a character's upbringing or chosen profession? You can't be a scholar if there are no books to read and learn from, and you would grow up very differently on a floating dirigible than in a farming village.

Will it affect culture, social status, religion, philosophy, politics, or government? One technology may have a huge impact on one of these aspects but very little on what happens day-to-day. Another could change an entire culture. It's up to you to figure out how much of an impact technology will have on your world in much the same way you decide how magic would.

Remember, your world can look and feel like anything you want it to be. But for the reader, you want to keep things consistent and explainable. Your aim is to entertain with a story full of conflict and challenges that your hero must overcome to win the day. Both technology and magic can move that narrative forward. Make it a great story.

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OSTENTATION AND SIMPLICITY: ARTISTIC MOVEMENTS AS WORLDBUILDING TOOLS

M. S. Jenkins

To me, exploring the future through fiction is actually an exploration of ideas and concepts already experienced by humanity. For stories to resonate in our hearts and minds, we must be able to relate to the characters' struggles, failures, and achievements. Many fictional stories draw from the deep well of historical events in part because binarily natured concepts (such as good and evil, peace and war, death and life, etc.) are well represented in the records of war, politics, art, and more. When worldbuilding, reviewing historical events and significant movements can help flesh out the great story you want to tell. One of my favorite college classes was about art history, and the historical significance of the artistic movements of the past captivated me. Their influence, intentional or not, on many works of fiction provides an interesting topic to explore. To this end, I assert that *Star Wars* draws from the Baroque movement, and *Star Trek* draws from the Neoclassical movement, funneling artistic elements encouraged and rejected by their respective movements into the narrative, aesthetic and design. They serve as examples for us worldbuilders of how to make our creation feel a little bit more real through the use of influential historical art movements.

Take a casual stroll through nearly any museum and you will find an intrinsic overlap between art and history. Art from the Renaissance (1300-1600 AD) not only displayed wealth and power but communicated the dominant morals and values of those in power at the time. *The Gates of Paradise* by Ghiberti Lorenzo is a perfect example of this concept. Made of gilded bronze, its doors depict five scenes from the Old Testament and directly
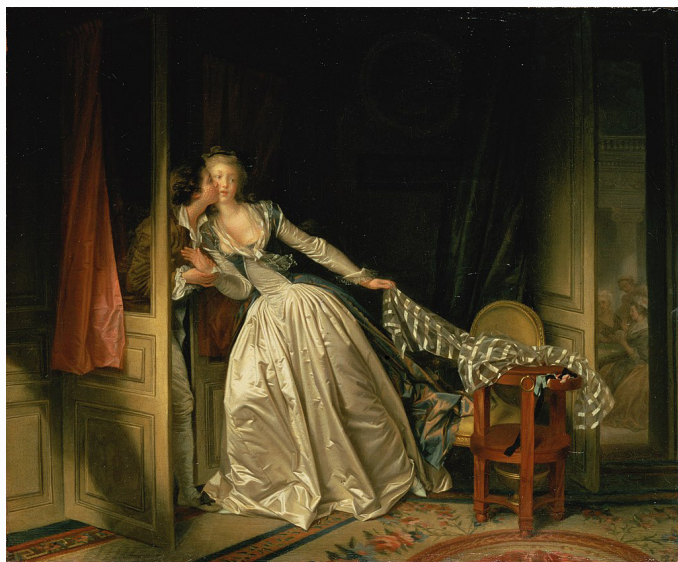

"The Gates of Paradise" by Ghiberti Lorenzo

demonstrates art's dual nature as a display of status and a way to nonverbally educate the public.

As the Renaissance gave way to the Enlightenment (1600-1700 AD), the artistic period known as the Late Baroque began, growing out from the French's rejection of the Louis XIV style art. Seventy years

later, another artistic movement rose in popularity from a revived appreciation for the art of antiquity, later known as the Neoclassical Art movement (1770-1830 AD). These two movements stressed different elements of culture, design, and ideology in their flagship artistic pieces. Understanding them and the contexts for their development will help us create or apply similar concepts in our own worldbuilding processes.

Many Baroque paintings that came out of France before the French Revolution (1789-1799 AD) are well known for their depictions of a frivolous aristocracy and overt eroticism. *The Stolen Kiss* by Jean Honore Fragonard iconically exemplifies the artistic use of light and dark, asymmetry, and pastel colors and thematic use of light-hearted or inconsequential depictions represent the core of the movement. Sculpture and architecture were characterized by grand presentations, gilding,

"The Stolen Kiss" by Jean Honore Fragonard

and sculpted molding as exemplified by the Ca' Rezzonico. This Italian building's humble exterior hides a wildly indulgent interior. Baroque paintings and architecture fill the building, which is common of many Baroque style structures.

In contrast to the Baroque's aristocratic soirées, the Neoclassical movement emphasized the value of more historical elements, and it coincided with two major world events that shaped its rise to popularity: the beginning of archeology and the rise of the "Grand Tour." To this end, Johann Joachim Winckelmann laid the foundations of modern

Ca' Rezzonico, Various

archeology by identifying the differences between Greek and Roman art. Meanwhile, wealthy, young European art students returned from Italy after studying classic works of art across the continent. Between the two, the public was ablaze with fascination for the past. Ancient European artworks, especially Greek and Roman, took center stage. Collecting trinkets and souvenirs of ancient art became quite fashionable, and many art galleries we enjoy today were built from the exploits of young, well-to-do Europeans. The principles ingrained in Classical art became a renewed foundation on which art was judged and valued, and with such different values, the Neoclassical movement was bound to be vastly different than the frivolous and lighthearted Baroque art that came before.

Jacques-Louis David's piece *Oath of the Horatii* is a wonderful example of Neoclassical artistry. While it shared the use of light and shadow with Baroque style art, the simplicity, symmetry, central perspective, and opera-like blocking of Neoclassical characters demonstrate a distinct departure. Furthermore, their position and expressions evoke strong emotion and purpose, which the Baroque movement generally lacked. Ancient Greek and Roman influence can be seen in the draped robes and stoic expressions of Canova's *Hebe* and the Nicolaus Copernicus Monument by Bertel Thorvaldsen.

Each artistic movement encouraged and discouraged different aesthetics, which can help us by acting as a backdrop for our worldbuilding. To demonstrate the point, we need to go back to the original premise of exploring concepts already experienced by humanity. I'm sure that most of

"The Oath of the Horatii" by Jacques-Louis David

you will be familiar with the saying "everything is a remix," and it appears to be more and more true as the story of humanity progresses. Two major science fiction franchises have a great amount of overlap with the topic we are discussing: *Star Wars* and *Star Trek*.

Star Wars, the beloved franchise begun by George Lucas, is really more fiction than science. It sells itself as a space opera because the stories never ask too many "what if" questions, and don't focus much on how technology affects society. It lacks explanation for critical bits of lore and technology: the mysterious element described only as the Force, the calculations for the jump to hyperspace, the power systems and weaponry of space ships, lightsabers, among many other technical questions. The narrative depends on the vastly deep well of an individual's destiny and tests of character, using the Force to explore those two elements. The reality is that the story it tells doesn't need those things explained, and might detract from the story if they were. In this universe, technology acts as the path from scene A to scene B, but does not offer any main plot points. The more important elements in *Star Wars* include Luke's struggles with his identity and Han and Leia's initially antagonistic romance, neither of which require intimate knowledge of the technology to be told well. You could pitch the same story in a low tech setting without much difficulty. Technology doesn't generally function as a character in a space opera, but this is not some codified rule of the genre. A great and obvious exception in *Star Wars* is the Death Star, and rightfully so. It functionally acts as a direct antagonist to the Rebel Alliance through the first and third movies, yet the franchise still lands solidly in the space opera category.

In contrast to *Star Wars*, *Star Trek* goes to great lengths to explain things you may or may not want to know about. Some of these include: what dilithium is and how it's used for interstellar travel, the difference between phasors and disruptors, why interstellar politics are just as frustrating as real world politics, how a Tox Uthat works, why cloaking devices and shields don't mix, and whether or not Data is in fact *fully functional*. *Star Trek* asks a lot of "what if" questions, and many of the stories grow out of the quest to explain the unknown. The technology works inversely compared to most space operas by giving technology the weight of a lead or supporting character. Technology here is often responsible for advancing the plot, creating tension, and influencing conflicts. Sometimes it can even overshadow the characters involved, but it doesn't mean character-driven stories are any less powerful within the genre. Names like James T. Kirk

and Jean-Luc Picard are so infused with character development that they are strong enough to carry the weight of an entire series focused solely on the individual.

Examining the first information communicated to the audience further solidifies the difference between the two monoliths of science fiction and how they approach storytelling. The logline from *Star Trek: The Next Generation* includes "…to explore strange new worlds, seek out new life and new civilizations…" The statement explicitly conveys that their mission is one of discovery and exploration which indicates the nature of the fiction. On the other hand, *Star Wars* begins with a trope-like fairy tale intro, "A long time ago, in a galaxy far, far away…" This opening primes the audience to consume a story that is character-driven with elements of morality. The contrast of these two loglines not only indicates how they differ at the outset but associates them with certain ideals, philosophies, and genres.

The aforementioned artistic movements and the two titanic book ends of science fiction share a lot of ideas. Many advantages can be found in exploring the similarities and differences between *Star Wars* and *Star Trek* that mirror those in the Baroque and the Neoclassical movements. *Star Wars* and *Star Trek* use elements they value to tell about the nature, beliefs, and desires of their associated protagonists. They likewise apply the elements rejected by each movement to the antagonists.

The largest contrast between the two comes from design. *Star Wars* showcased a lot of sets and props that coincide with elements of the Late Baroque period, particularly in terms of asymmetry and pastel colors. The association of the antagonistic forces with Neoclassical elements rejects Classical ideology. The long, sterile corridors and sharp, angular aesthetic of the detention block on the Death Star distinctly contrast Baroque principals. Even the triangular shapes of the star destroyers and super star destroyer and the identical uniforms of the stormtroopers reflect the same rejection. Conversely, our protagonists have a variety of ships that look like they were accidentally made by an explosion at a salvage yard. Luke even gawks at "what a piece of junk" the *Millennium Falcon*
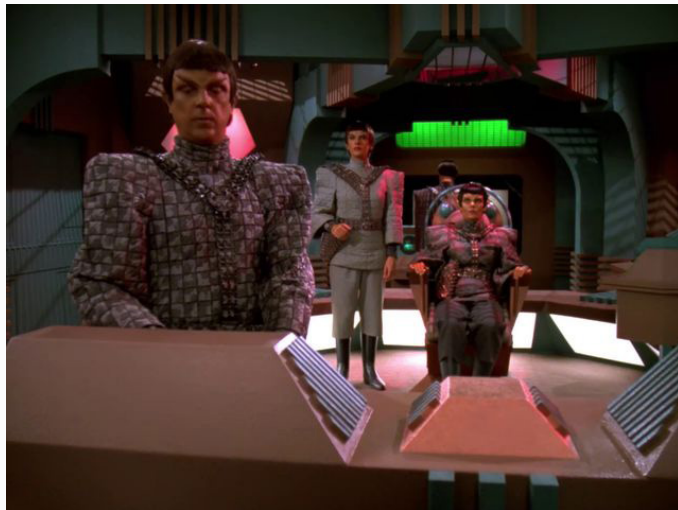

Star Wars

appears to be only for Han to reassure him, "She'll make point five past light speed. She may not look like much, but she's got it where it counts, kid." The heroes are defined by their disorganized, scrappy *realness*. The villains are defined by their organized, structured *facade*. The emphasis on depictions of real life in the Baroque movement again lands solidly on the side of the protagonists.

In terms of design, *Star Trek* takes an alternate route, creating the inverse of what I've just described. It sets up the organized, structured, clean, and angular to be associated with the Federation as the lead protagonists. Initially, the Klingons stood in as villians, and the design of their ships, aesthetic, and culture emphasize the same elements that the Late Baroque do, albeit a harsher, more violent version. In *The Next Generation*, the inside of a Klingon warbird is dimly lit, less organized, dirty, and asymmetrical. Other villains, like the Romulans, and frenemies, like the Ferengi, don't share these design choices. Instead, some of them are represented as an inversion of Neoclassical ideas. The vanity of Ferengi ostentation and the treacherous

Star Trek: The Next Generation

nature of Romulan diplomacy reject the simplicity and order of the Neoclassical. The Borg and the Dominion don't seem to fit well into either category as they cross the line between the Baroque and Neoclassical too many times to be fully one or the other.

Star Trek: The Next Generation

Now, how can worldbuilders use this information? Even a cursory understanding of art history can help you design species, cultures, and aesthetics for an extremely effective narrative experience. As diverse as *Star Wars* and *Star Trek* are in their source material, they clearly, but perhaps unintentionally, use art history to inform decisions about setting, visual tone, and character design, resulting in some wonderful worldbuilding. Their narratives draw on human conflicts: new versus old, symmetry versus asymmetry, ostentation versus simplicity. They embed these conflicting ideologies into the values, motivations, and desires of the settings' characters and species. Understanding the conflicts and controversies of the past provides insight into our own organically developing culture, which serves as the foundation for all fiction no matter the subject matter.

ART HISTORY MADE PRACTICAL

Imagine making a species from scratch. They are aliens and have little in common with humans other than similar bipedal anatomy. Beyond this point, we're not sure what to do with them. In my own worldbuilding, I use a six-step process I call the "genuine imitation" method that can be seen in the infographic to the right.

6

Genuine Imitation
Worldbuilding Process

developed by M.S. Jenkins

01 — Anatomy and Physiology

02 — Language

03 — Art

04 — Society & Economy

05 — Government & Military

06 — History

SOURCE
https://dark-matter-project.weebly.com/
IMAGE CREDIT
Image by Yuri B from Pixabay

M. S. Jenkins

Since we have focused so much on Baroque and Neoclassicism, it would be best to step away from them for our example. I chose Impressionism since it's a relatively recent artistic movement that many modern sources have analyzed. Before we begin building, it would be helpful to take a quick look at the important parts of the movement to get an idea of directions we can explore.

Impressionism, in principal, rejected academic painting styles, preferring freeform brushing as opposed to coloring within the lines. It also focused on the variable effects of light, vibrant colors, implied movement, and scenes of everyday life to capture human perception. Taking note of the things that Impressionism values and rejects helps

us set a starting point for the species. Through this lens we might develop an anti-academic species, or one that favors using a less formal academic social structure. This design could also have ramifications on social hierarchy and interactions, depending on how the individual is valued. A common metric in our society today appears in academia. People with Master and Doctorate degrees command more authority and respect on a subconscious level, so removing this notion from our perception is a worthwhile thought experiment.

Anatomy and physiology are important to consider in building any custom race, especially when they deviate from our own. The consequential effects they can have on other developmental elements are very significant. The Impressionist influence could be manifested in a more lively variety of skin tones or feathers which reflect the value of vibrant colors and implied movement.

A direct effect of diverse anatomy would be differences in linguistics and communication, as the anatomy would inform their means of communication and the foundation of their linguistic system. Skin pigment changes reflecting mood or emotions would provide a basis for lower level communication while a large alphabet, words with multiple meanings, and very loose grammatical rules would make their communication consistent with principles of Impressionism but also feel very alien.

Impressionism's emphasis on everyday scenes might manifest in our alien species as either a fondness for something lost or a thing of inherent importance to their culture, such as how afternoon tea has been an essential part of the English lifestyle since the 1840s. While more philosophic ideas can be drawn out of further reading, the more exciting work is describing the aesthetic.

With Impressionism's emphasis on implied movement, we can do a lot of exciting things with technology. Imagine a starship with a command center that involves a lot of movement, computer consoles with fewer right angles, more curves and more vibrant colors, and a well-lit, less utilitarian structure. How about medical tools and weapons that have localized floating parts? What about

engines that use light as fuel and a black hole for power in a beautiful display of warped space-time? Should there be a deck on the ship specifically dedicated to "everyday life activities" or maybe a proper coffee shop connected to the galley? The more time we spend exploring the Impressionist movement the more inspiration we can find, though not all of them will be original.

Admittedly, many of the examples show aesthetics that have already been used in works like *Halo*, *Alien*, and others, but your unique expression of these ideas is yours and yours alone. *Star Wars* and *Star Trek* draw on concepts that came long before them. They are the eccentric expressions of the individuals who created them. When developing future worlds, looking over our shoulders at history helps us understand the tempests of the past and squalls on the horizon ahead. More importantly, this approach, among others, will help you inculcate the important events of our past and put them on display in the conflicts, cooperation, and cataclysm of a hypothetical future. Michelangelo—the famous sculptor, painter, architect, and poet—had said, "Every block of stone has a statue inside it and it is the task of the sculptor to discover it." You, the sculptor, have the immensely pleasurable burden of carving out the exact image you see in that block. Whether you see ostentation or simplicity hiding beneath the surface of the marble, it is, and always will be, a labor of love. 🪐

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ASK US ANYTHING

Adam Bassett

This Ask Us Anything is presented by a senior member of the Amalgamated Order of Interdimensional Persons, Percival Aluminius Illumnius, Adjunct Professor of Gateways, 3423 WestNorth Street, Dunny-on-the-Spire.

M. E. White

Under what conditions can knowledge/information/ technology be lost? Must it be caused by sudden actions (like the burning of a library, for example), or can it happen gradually over time? If so, how?

Generally, the answer is a simple yes. If we must break it down, then I would argue you've already touched on the more obvious ways we can lose collected knowledge. The burning of the Library of Alexandria (also, Temple of the Muses, or the Musaeum) was a massive blow to human civilization, for example. Once, it contained the works of *reasonably* intelligent minds, such as Homer, Plato, and Socrates. It was not just a library for the city, but for the world, amassing as much learning as it could in one place for scholars and critical thinkers to study.

And then it burned to the ground. Of course, you can replace the fire with any form of treachery or natural disaster. A flood, earthquake, or break in time and space may have had a very similar effect. Sabotage is also a fun method. Perhaps somebody intentionally burned the building, detonated it, or stole valuable materials from the public.

Like you suggested, sudden losses are only half the issue. As generations pass, certain understandings may fall out of relevance and be lost simply because fewer people over time care to learn some things. For example, if wild bears were a major threat to people, they might develop strong walls to keep them out. Understanding of the beast would fade over time as regular citizens wouldn't have to deal with bears anymore. That knowledge may belong solely to guards and hunters. If the bears are overhunted or migrate away, that would cultivate a similar apathy for bear knowledge.

What we're getting at here is a slow fading of specific knowledge will often be caused by either a necessity vacuum or a gradual reduction in the population that possesses that knowledge. If two groups are warring, for example, let's say that one extinguishes the other. The fighting dragged on for a while and is sufficiently dramatic, but it took a decade or two for the nation to fall. Afterward, the survivors would have fled or assimilated. Their old cultures would fade, as there are now fewer who know the stories, and some would fully adopt new practices. If I may generalize things a bit, we see this to an extent with Zoroastrianism—a religion that was once mighty but has since dwindled to a few small practicing groups. Nowadays, you rarely hear about them or their faith, but they flourished under the prophet Zarathustra (628-551 BCE).

Barbarossa

How realistic is it that interstellar colonies would want freedom?

Assuming that this colony hasn't managed to wrap their heads around faster than light travel, just getting there will take most or all of a lifetime. One of yours, anyway. A colony at interstellar distances is in some ways already free, as their mother country cannot reasonably provide for them in any meaningful way with such a delay in transported supplies and communication. Therefore the colony must by design or by necessity be fully self-sufficient. Any ingrained sense of loyalty will likely erode under the reality of even a basic call taking literal years to reach its destination.

However, if faster than light travel exists you could replace "interstellar colonies" with...most anything, really. The distance between interstellar colonies could create some unique scenarios but the situation is not dissimilar to the African or New World colonies once held by European nations. Again, we can turn our views toward history, in any dimension, to answer this query.

There is always a catalyst for revolution. An oppressive government, lack of representation, external conflict, ineffective rulers, and so on. It is, in my experience, part of human nature to strive for freedom and freedom of expression (of course that concept is null and void if your people are non-humans). The question then becomes, is there a catalyst for this interstellar colony to revolt? A few examples might be poor communication to the homeworld, which promotes cultural drift, or you could go the classic taxation without representation route. Bonus points if you use multiple inciting causes.
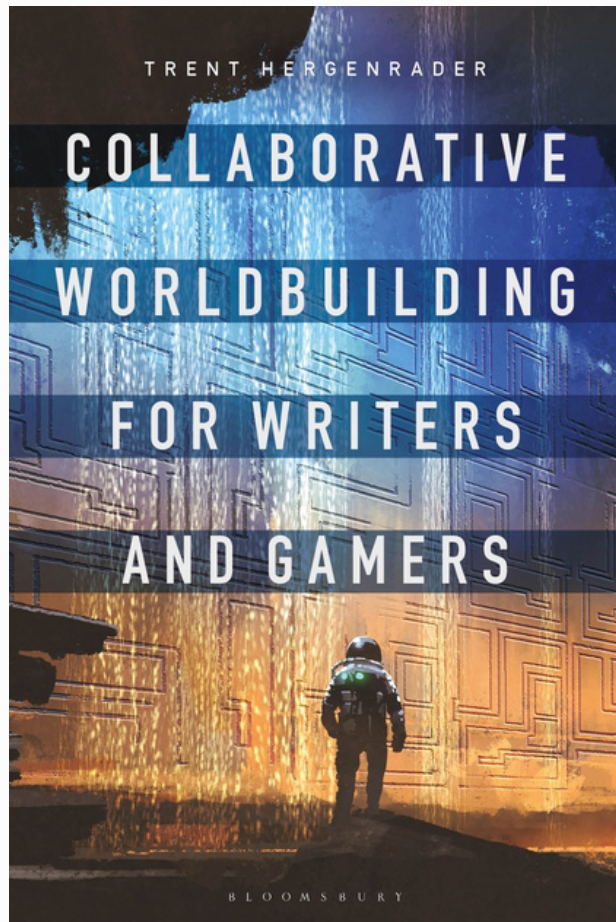
Tristen Fekete

How much exposition is too much exposition? And when is the proper time to use it?

The answer to this will vary depending on who your reader is. Some people prefer the bare minimum of exposition, others like the deep lore. A middle-ground is likely the answer, but what that is will also vary depending on the person, subject matter, and relevance to the story you're working on. Truthfully—and it pains me to admit this—this is something that I cannot answer. The best advice I've found is this: write in a way that best suits what you're trying to accomplish. Then, when you have a solid draft, find a few friends to read it and ask what they think. If your friends are terrible, lacking in taste, or simply not on your intellectual level, there are writing communities everywhere that you could join. Exposition is tricky, and while it's good to keep in mind that old mantra "show, don't tell," the best method to get it right is simply to practice and share it. 🪐

Class has ended. We'll see you in two months. If you would like to submit your own questions for the next Ask Us Anything segment, submit questions to us via our email or Discord.

r/FantasyWorldbuilding

LET'S GET TO WORK

STAFF PICKS

Title: *Collaborative Worldbuilding for Writers and Gamers*
Author: Trent Hergenrader
Publisher: Bloomsbury Academic
First Edition: 2018
Chosen by: Adam Bassett
Media: Book

Professor Hergenrader teaches worldbuilding and creative writing at the Rochester Institute of Technology in New York State. In this text he helps readers ask important questions as they build worlds of their own much like he does with his students. Use it as a reference or a guide to grow that fictional place you've been working on.

AETHERPUNK

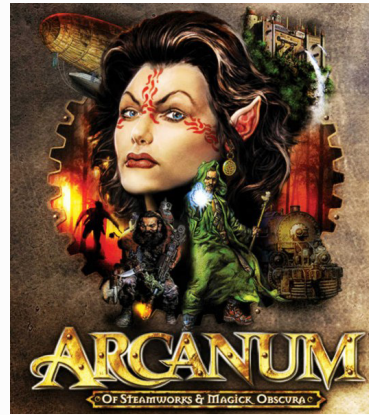

Title: *Arcanum: Of Steamworks and Magick Obscura*
Author: Troika Games
Publisher: Sierra Online
First Edition: 2001
Chosen by: deificat
Media: Game

This is your usual high fantasy world but thrown into the industrial age with Victorian vogue architecture. The struggle between technology and magick is the recurring plot of the game.

[B] *Aeronauts Windlass* series by Jim Butcher
[B] *Thunderer* by Felix Gilman
[B] *Clocktaur War* duology by T. Kingfisher
[CB] *Girl Genius*

BOOTSTRAP ENGINEERING & SOLARPUNK

[B] *Chameleon Moon* series by RoAnna Sylver
[B] *Destiny's Crucible* series by Olan Thorensen
[B] *The Martian* by Andy Weir
[B] *Mars* series by Kim Stanley Robinson
[B] *Parable of the Sower* by Octavia Butler
[B] *Seveneves* by Neal Stephenson
[M] *The Martian* (2015)

ATOMPUNK

[B] *Trope Namer* by William Gibson
[M] *Despicable Me* (2010)
[M] *Mars Attacks* (1996)
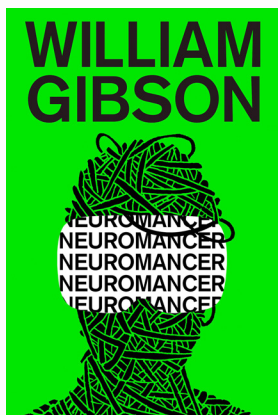[M] *Zathura* (2005)
[TV] *The Jetsons*
[TV] *Kim Possible*
[TV] *Meet the Robinsons*
[VG] *Fallout* series

STAFF PICKS

CYBERPUNK & BIOPUNK

Title: *Neuromancer*
Author: William Gibson
Publisher: Ace
First Edition: 1984
Chosen by: Cathy, the Overprepared GM
Media: Book

A wildly imaginative, widely lauded work, Neuromancer popularized Cyberpunk as a genre. The story centers around a data heist by a drug-addicted hacker and his cyborg girlfriend but also explores the unlovely potential of technologies such as artificial intelligence, bioengineering, and prostheses.

[B] *Darwin* series by Greg Bear
[B] *Do Androids Dream of Electric Sheep?* by Philip K. Dick
[B] *Scarabaeus* duology by Sara Creasy
[B] *The Sky Lords* trilogy by John Brosnan
[CB] *Battle Angel Alita* (1990–1995) by Yukito Kishiro
[M] *Blade Runner* (1982)
[M] *Gattaca* (1997)
[TV] *Altered Carbon*
[VG] *Cyberpunk 2077* (upcoming game)

DIESELPUNK

[B] *Dreadnought* by Cherie Priest
[B] *Iskriget* by Anders Blixt
[CB] *Astrocity*
[CB] *Hellboy*
[CB] *Marvel Noir*
[M] *Captain America: The First Avenger* (2011)
[M] *The Rocketeer* (1991)
[M] *Sky Captain and the World of Tomorrow* (2004)
[TV] *The Legend of Korra*

STEAMPUNK

Title: *April and the Extraordinary World*
Authors: Christian Desmares, Franck Ekinci, and Benjamin Legrand
Publisher: StudioCanal (France), Gkids (US)
First Edition: 2015
Chosen by: Jaren J. Petty
Media: Movie

Set in an alternate history, steampunk version of the '30s and '40s, this film shows off some of the best and most intriguing worldbuilding I've seen in a steampunk film. What begins as a search for April's kidnapped family quickly turns into a race to save the world from both all-out war and environmental disaster.

[B] *The Black God's Drums* by P. Djèlí Clark
[B] *Buffalo Soldier* by Maurice Broaddus
[B] *Dreadnought* by Cherie Priest
[B] *Infernal Devices* by K. W. Jeter
[B] *Leviathan* by Scott Westerfeld
[B] *River of Teeth/Taste of Marrow* by Sarah Gailey
[B] *The Year the Cloud Fell* by Kurt R. A. Giambastiani
[B] *Zeppelins West* by Joe Lansdale
[M] *League of Extraordinary Gentlemen* (2003)
[RPG] *Deadlands RPG*
[TV] *The Wild Wild West* (1965)

FAR FUTURE TECH

[B] *The Broken Earth* series by N. K. Jemisin
[B] *Dune* by Frank Herbert
[B] *A Fire upon the Deep* by Vernor Vinge
[B] *Foundation* trilogy by Isaac Asimov
[B] *Gods, Monsters, and the Lucky Peach* by Kelly Robson
[B] *The Quantum Magician* by Derek Kunsken

PROMPTS

In 1964, Nicolai Kardashev created the Kardashev Scale, which ranks civilizations' technological capabilities by the energy they can harness. How do your civilizations rank on Kardashev's scale? What key features put them on that level?

What kinds of technological applications (e.g., entertainment, medical, etc.) do the people of your world enjoy? Are any of the items divisive and if so, how?

How accessible is technology in your world? Are there any divisions based on who has access to or can afford certain tech?

What regions are known for particularly severe weather, such as what we see with Tornado Alley in the United States or Monsoon/Rainy Season in India?

Are there any unique elements/minerals in your world? If so, what are their uses?

What types of crime are commonplace in your world's societies? Which, if any, are considered unforgivable?

If you would like to write a short story based on one of the writing prompts or have a prompt you would like to share with us, please submit it to contact@worldbuildingmagazine.com or on Discord/Social Media.

Submission Requirements:

Submissions must be no longer than 5,000 words

The submission must include title and author(s) in case of questions.

The Kardashev Scale

Off-Scale
0 — To find a place on the Kardashev Scale, a society needs to *at least* harness and control all of the planet's energy. Humanity hasn't quite managed that yet.

Planetary
1 — Type one societies have gained mastery of their planet. They have control over its natural forces, such as volcanoes and weather, and control over all energy sources. These societies can also gather some energy from the neighboring star.

Interplanetary
2 — Type two societies can gather all the energy of their star through megastructures such as a Dyson Sphere. At this point, fusion energy has been mastered, and they have large amounts of disposable energy.

Interstellar
3 — Type three societies are intergalactic travelers, able to move from star system to star system without difficulty and able to colonize. Humanity may have advanced to become cybernetically enhanced. Those who have not taken this step this may be considered inferior.

Intergalactic
4 — Type four societies can harness the entire energy of the universe. It is possible they could alter the structure of space-time and have evolved far past what we see as Humanity today.

Universal
5 — Type five societies harness the power of multiple universes. They may jump between multiverses and, by our perspective, behave like gods.

Adam Bassett

MEET THE STAFF

Curated by WithBestIntentions

I'm deïficat (/de.i.fi.kat/), one of the Artists at Worldbuilding Magazine. I commit what spare time I have to make art for the issues and have fun in Discord. I found the magazine on Reddit during the 'Creature' issue back in August 2018 and couldn't help but take interest because of my new love for worldbuilding and the fact that I used to layout magazines. I immediately volunteered to make art for the next issue.

My worldbuilding is more of a product of frustration with real-world politics influencing land use and urban planning rather than design and efficiency. Then it evolved into a passion. I worldbuild mostly in my mind, but I hope that I will be able to flesh it out into something more tangible this year.

I will tell you about my world through the belief of the most dominant in-world religion. According to this still unnamed religion, the universe is called The Grand Orrery and is created by the Clockmaker. The universe is held together by clockwork machinations. Isbur, one of many worlds attached to the Orrery, is flat and bound by a great ice wall. Magic is new to the world, and it is still being studied to better understand it. Vibrations through the universe power both the magic and technology of Isbur. The source of energy works like extremely exaggerated piezoelectricity in which vibrations are accumulated in certain solid materials as energy due to applied mechanical stress. Some people are able to sense this energy and vibrations while fewer are able to control, channel, and amplify them. In the same sense, this energy fuels technology in Isbur.

I mostly work in the architectural field as a main career and do graphic design as a side gig. Digital painting is a recent rekindling of my old love of drawing from when I was a kid. I worked as a landscape designer in Shenzhen, China and as a Construction Supervisor in Middle-East. Now I'm in the Philippines designing residential houses and the sparse landscape work; it isn't big here like in China. I spend my leisure time traveling with family across the archipelago and the neighboring countries. When I don't have the time or the budget for that, I watch Netflix with my loved ones. I used to play lots of PC games and read books, but I don't have that time anymore.

I drew the cover page for this issue and if you want to see more of my digital scribbles, here's my Facebook page & Twitter. I'll leave a picture of my favorite plant I use a lot in landscaping huge spaces!

LETTER FROM THE EDITOR

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Z:/worldbuilding/magazine> letter_from_the_editor.exe --greeting

Hello worldbuilders of the Milky Way galaxy!

Z:/worldbuilding/magazine> letter_from_the_editor.exe --introduction

Thank you for reading our Technology issue! The team has put in a lot
of hard work to write, edit, and illustrate this edition, and we're so
happy to see it come together. We hope, as always, you find it helpful
in your world construction. [BEGIN LEGAL DISCLAIMER](Note: Terraforming
is still pending approval by the Galactic Planetary Development
Oversight Bureau, so we do not condone such an action. Please consult
with your solar magistrate before beginning a development project.
Side effects may include severe weather pattern disruption, creative
obsession (a.k.a. "God Complex"), bankruptcy ...To read the full
disclaimer text, re-run this command with the --VERBOSE flag)[/END LEGAL
DISCLAIMER]

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We've been looking forward to this issue for a long time. Many worlds,
including my own, use a single piece or system of technology as the
keystone of their worldbuilding. Even more common is the use of
technology to facilitate the plot of a story—whether through clever
usage of existing tech, like warp travel or teleporters in Star Trek;
or technological advancement providing an unexpected advantage, like
the bombs that the forces of Isengard used to breach Helm's Deep in The
Two Towers.

I believe we've got a stellar set of articles in this issue, and I
hope that you've enjoyed your visual parsing of them. I'd like to thank
our writers, editors, artists, and the organizers and marketers of the
meta department for all their hard work in creating and perfecting this
issue. I'm proud to be a part of this team and am humbled by their
passion, creativity, and expertise. Everyone's willingness to pitch in,
help each other out, welcome new faces, and bring this magazine to life
every two months is incredible.
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Z:/worldbuilding/magazine> letter_from_theeditor.exe --enlist

ERROR: FILE NOT FOUND: 'letter_from_theeditor.exe'

Z:/worldbuilding/magazine> letter_from_the_editor.exe --enlist

Speaking of this amazing team, we'd be honored to have you on board.
Yes, you, the reader. All of us are regular Joes that came from various
places in the worldbuilding community—and if you're reading this,
you're a part of that community too.

We're always looking for new people to help make the magazine even
better and contribute to this wonderful community, whether you're an
artist, organizer, editor, marketer, writer, or just wanting to help.
Send us an email at contact@worldbuildingmagazine.com or join our
Discord server to hang out with us! We also have many other cool things
there that aren't related to the magazine: RPG one-shots; a book club;
spaces to get and provide art, writing, or worldbuilding critique; and
our new collaborative worldbuilding project.

Z:/worldbuilding/magazine> signoff

ERROR: COMMAND 'signoff' NOT RECOGNIZED. USE 'help' TO SEE A LIST OF
AVAILABLE COMMANDS

Z:/worldbuilding/magazine> logout

Happy Worldbuilding!

- LieutenantDebug, Vice Editor-in-Chief

*session ended*
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