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Contents

CHAPTER 1

Deathstar Design

A common criticism of "Star Wars: A New Hope" is that the exhaust leading straight to the reactor was an obvious design flaw, and that it was clearly just there to have an easy way of blowing up the Death Star.

Really?

The death star has amazing defensive capabilities: the guns take out most big ships. Some small ships can sneak in, during a co-ordinated attacks. Presumably, the Empire is well aware of X-wing capabilities. It is unlikely they have not managed to steal even one.

The designer of the Death Star knew those capabilities. However, the death star poses its own unique design challenges. Let us remember, the reactor, even when not operating the weapon, has to sustain a *moon-sized* space ship. When operating the weapon, it has to output enough energy to literally blow up a planet.

This means immense heat output reequirements. The exhaust port needs to get rid of all of this heat into what is the perfect insulator: the vacuum of outer space. Presumably, some high heat-density liquid is heated up and then the gasses forcefully ejected through the port.

Now, doubtless the designer was aware that this can lead to the possibility of a bomb being dropped into the port and blowing up the station. Careful measurements were done: in thousands of careful simulations, with the empire's best pilots, nobody could use an X-wing targeting computer to hit bombs into the port. They managed to make the port tight enough that it was impossible to hit with the best technology available to the rebels.

The empire has spent the last ten years hunting the remaining jedis. There are none left, or any that are left are deep in hiding and dare not show themselves. There was no reason to make the death star imprevious to those mythical beings, and the designer of the death star, almost certainly, was not given the mission to do so.

1.1 Addendum, in view of Rogue One

We know Galen Erso placed the "vulnerability" there intentionally. But he was not the only designer of the death star: this design had to pass the review of multiple people. We know that the rebellion is aware of the survival of Obi-Wan Kenobi: Leah's message is for him. The emperor knows that, at least, that Obi-Wan and some other jedis are unaccounted for, and survived order 66. However, though the emperor and Darth Vader know it, this is not common knowledge in the Imperial forces, much less the details of the jedis' abilities. Galen "trusts in the force": he believes

the surviving jedis will be able to use the vulnerability. The empire's weapon designers, however, do not know jedis have survived order 66 and need to be accounted for.

CHAPTER 2

High School Geometry Is Child Abuse

The "modern" textbook teaching geometry is basically a badly translated "Euclid's Elements", together with, hopefully, some modernized exercises. They all contain the same material, because they are all based on the same ~2300 years old text.

In itself, this is not bad. Euclid was a pretty smart person. Math does not change. However, while math is perfect and immutable, humans are neither. Euclid definitely was not. He missed an axiom.

In 1882, Moritz Pasch discovered a missing axiom. Informally, it states: "If a line, not passing through any vertex of a triangle, meets one side of the triangle then it meets another side."

We can amend our geometry textbooks, of course. We should have done so for the last 140 years! But it is worthwhile to consider not only why Euclid, professional smart guy, as well as many smart students and teachers for, literally, over two thousand years, could have missed it.

The reason is that what we call "proofs" in geometry, following Euclid's definition from ~300 B.C., are nothing like what a mathematician would call proofs. They are an intuition aid to proofs: pictures made to inspire a proof. But instead of teaching people to use that intuition and write a formal proof, we say that these pictures are proofs by themselves!

Of course, intuition aids are invaluable teaching tools. But confusing the teaching tools for the goal, this is an injustice to every kid.

We could, again, amend our geometry textbooks: not only to add the missing axiom, but to show how to write a formal proof in geometry, one that takes the axioms, and manipulates them to arrive at the conclusion. We could teach how to get inspired by the picture to come up with a proof.

Now is the time to mention DeCartes' project, to reduce geometry to algebra. It succeeded, though it would take another century to properly define what he did: he showed that planar geometry, as a formal theory, taking Euclid's axioms and adding the missing one, is equivalent to the theory of real-closed fields.

More years passed, mathematicians made more advances, and discovered that the theory of real-closed fields is algorithmically quantifier-free.

In other words, we can write an algorithm that will reduce every statement about real-closed fields into a quantifier free formula. There are not that many quantifier free formula: without free variables, the only two, up to equivalence, are `1=0` and `0==0`. With free variables, they define the solutions to a polynomial equation, or a polynomial inequality.

In short, we can write an algorithm that will solve any problem in a "modern" geometry textbook. Our "high school math" curriculum is basically teaching kids to do the job of a calculator, poorly.

If we want to teach students how math works, there is a much nicer way. Finite set theory. Here is how we would teach finite set theory:

First lesson:

- Present "naive set theory"
- Show Russel's paradox
- No homework

Second lesson:

- Explain how axiomatic set theory works: Von Neuman version
- Present some of the axioms (pair, union, replacement)
- Show how to prove the union of two sets is a set
- Independent work: prove the intersection of two sets is a set

Third lesson:

- Present some more axioms
- Show some more things are sets
- Show Venn diagrams as intuition aids
- De Morgan's first law: Show with Venn, then show formal proof.
- Independent work: De Morgan's second law

We would progress throughout the year, presenting the formal axiom of Von Neuman Choice set theory, and proving various results. Finally, we would get to the axiom of infinity. There would be one lesson where we show the axiom of infinity, but then we show that we can assume its negation. This is finite set theory!

Now that we have all this theory, we can build natural numbers. Define the ordinals. Define addition, multiplication. Show that the rules apply.

We can even try to build the integers: not the elegant construction with equivalence classes, since we do not have infinite sets, but we can just add "formal negatives" and define the rules of arithmetic the right way.

Having built the integers, we can build the rational numbers: again, no equivalence classes, but we can define them as irreducible fractions.

We would still use pictures as teaching aides and guides to develop understanding. No teacher would deny kids this tool. But there would be a distinction between the tool ("use it to figure out an approach and learn what is going on") and the goal ("write a formal proof").

This would fulfill the original stated goal of the geometry curriculum without:

- Lying to kids without math
- Teaching them to be bad calculators
- Confusing them about what is a proof

Wouldn't that be nice?

CHAPTER 3

D&D is Bad

I grew up on the original D&D, and then AD&D 2nd edition. Some of my favorite times were playing these games. I love role-playing. I love role-playing in fantasy worlds.

The D&D game is bad. It is so bad, no minor update can rescue it. If you like role-playing, you will love some alternative systems, and you will never be able to go back.

3.1 D&D's Magic System is Inadequate

The once-a-day spell slot system is based on Jack Vance's Dying Earth series. As the name implies, in this series magic is dying. The reason mages can only memorize a limited number of slots, and the spells fade after they are cast, is because magic is literally dying.

If it was meant as a magic system for this setting, or for a vaguely similar setting, that would be great. But this is not the typical setting. The official source materials, as well as most people's home-grown campaigns, feature worlds rife with magic.

Even where mages are rare, they are powerful and at the top of their games. Yet, they live with a magic system that is based on a totally different genre.

3.2 D&D is not Generic Enough

D&D was written to allow a wide range of fantasy settings. Yet, classes and races are hard coded, and the system is intentionally designed such that new classes and races are not as good.

The only fantasy settings that it is even a little bit of a fit for are the Tolkien-rip-offs. Even there, it took a stereotype of the frail wizard and superimposed it on Tolkien's setting. All of D&D's settings are slightly reskinned Forgotten Realms.

3.3 D&D is too Generic

The core system is not optimized for a particular settings. It cannot say "Mountain Dwarves hail from the mountains to the north", because it is supposed to allow deserts in the north. It does not come with a built-in world, and is super-tuned to it. Because of that, the mechanics are plain and without twists. There is no official way to add twists, so everyone plays with house rules that, almost certainly, have issues with them.

3.4 Racism

Each non-human race has common mental traits. Dwarves are dour and tough, elves love magic, and hobbits enjoy good meals. In D&D, this is not based on who raised you: oh no, nature over nurture.

While other systems, when they try to allow for non-human races, will often separate the physical traits (hobbits might be shorter and cannot be as strong as the strongest humans) with cultural traits that depend on how a character grew up, D&D just decided that all dwarves dislike magic.

3.5 Levels

The level system is bad. Suddenly, after reaching a threshold, all abilities, even ones that were not used, get better.

Sure, there might be an in-game explanation that after enough experience, you go off and train with a mentor. Which is just a weird way to justify a rule, instead of doing away with it

3.6 Combat

Armor Class (AC) ties together both armor and ability to evade blows. Additionally, HP rising with levels means there is a weird "way to avoid blows" that, by chance, heals just like the body does but is... not visible? Or partially visible? What does it mean when a human, normal-sized, fighter has 80 HP and suffers a 10 HP blow? Such a blow would kill any normal human, and yet the fighter barely notice. A 5 HP blow would incapcitate any person, but eventually they will recover. In exactly the same amount of time, the fighter will only recover from the marginal effect of a scrape.

A round is a minute. In that minute, most normal characters can only hit once. Tell that to anyone who fights with a sword and learns they can only take one swing. The excuse is that "this is accumulative", but this does not look like real battle at all. The amount of total damage would be on a bell-curve if it is accumulated from many blows. Also, somehow, arrows or other missiles are accounted for by attack, not with a "cumulative" number.

3.7 Saving Throws

Saving throws are at once too abstract and not abstract enough. Is a wizard really good at saving throw v. magic because they can soak up the magic? Then why do they gain a benefit from dexterity?

3.8 Magic Items

Because the leveling system applies to all skills at once, the ability to gain specific high proficiency is limited. In order to compensate, most campaigns are aglut with magic item. A level 10 fighter without a +4 Sword, at least, has a miser for a DM. This means that magical items do not have a history, a plot, a personality: they are just a high positive number for attacks.

3.9 Rolling a Character

Character creation involving randomness is ridiculous. The original rules (just roll dice and then figure what you can play) were so ridiculous (ah, a party with three clerics and no fighter because nobody rolled high STR?) that eventually everyone just goes for the "roll lots of dice and choose the best one and also place them where you want". Those quickly converge to low randomness, but without making the final leap to just a point system, they involve taking a lot of time to roll dice, for the sole benefit of reducing the randomness.

Rolling for a level's HP is the absolute worst. Levels take a few sessions to get, and rolling a 1 on the HP roll is the worst disappointed. In practice, most campaigns I played just went with "you get the max HP", otherwise at level 5 you can easily get unlucky enough to have a fighter who can't last a fight with a lucky guard.

3.10 Dice

D&D requires six kinds of dice. Players need to train themselves to quickly mapping dN to the right shape. Additionally, people must carry complicated, special-purpose, dice packs. This would make sense if somehow gameplay was so much better, but almost every other system uses one or two kinds of dice, without any reduction in fun or excitement.

3.11 Alignment

The alignment system literally adds nothing to the game. It is there, it results in some minor player penalties and maybe a weird limitation o Paladins and Druids, and that is it. If nobody is playing a Paladin or Druid, the whole system could be thrown out and nothing would be different.

There are much better ways to balance over-powered classes. If you want "behavioral limitations", put them right in the class. Alternatively, make the class weaker.

3.12 Summary

If you love table-top role playing games, why use the oldest system that has been patched and patched, and is still not good?

Get Hero or GURPS if you like making your own campaign worlds. If you want fantasy, get the fantasy supplements for these, which will lead you through the options you have. Since they are based on generic systems, you build your own magic system: or even several, if you want priest magic and wizard magic to feel completely different.

If you want a ready made campaign world, get something that has a flavor. The Amber Diceless system. Changeling: The Lost. Shadowrun. Ars Magica.

Either direction guarantees more fun than using D&D, even if you sometimes have to drag people kicking and screaming into the light.

CHAPTER 4

Pi is Wrong

This is not an article about Tau. (Of course Tau is the correct way to think about circles and not Pi. This is obvious and will not be mentioned further.)

Pi is a famous constant. People celebrate Pi day, memorize Pi's digits, and engage in other forms of math-inspired play around in it. But does it deserve its fame? What is Pi actually doing?

Instead of talking about that, let's start with a tangential issue. We expect differential equations that describe the real world to be *position independent*. This means that the free variable should not appear in the equation, otherwise physics would look different based on where you are.

When thinking about such differential equations, we can think about the simplest one: `f' = f`. A function whose deriviative is equal to itself. One such function is too simple: `f(x) = 0`. This constant function has a derivative of `0`, which is equal to it.

Can there be other solutions? It's not obvious but let's call a function that is *not* always `0` and solves this equation, if it exists, `p`. Now, `p` can *never* be `0`, because this equation is position-independent. If it's zero anywhere, then the derivative is `0`, and so it is a zero constant.

So this means `p(0) = t`, and `t` is not `0`. Notice that because derivatives are linear, if `p` is a solution, so is `a*p` for every constant `a`. So, the function `e(x) = p(x)/t` also solves the original differential equation, and `e(0)=1`. The equation is position-independent, so `e(x+c)` is also a solution for each `c`. Since differential equations have unique solutions with the same starting conditions, and `e(0+c)/e(c)=1=e(0)`, `e(x+c)/e(c)=e(x)`. In other words, `e(x+c)=e(x)*e(c)` for every `x` and `c`.

With induction,

```
e(n)=e(1) ** n
```

More,

```
e(n/m) ** m = e(n/m * m) = e(n) = e(1) ** n
```

Taking out `m`-th roots,

```
e(n/m) = rt_m(e(1) ** n)
```

If we just write `e` for `e(1)`, we get

```
e(r) = e ** r
```

for every rational number `r`.

Since `e' = e`, we have `e'' = e` and so on. In other words, every derivative at `0` is `1`. So the Taylor series looks like

```
e(x) = 1 + x/1! + x**2/2! + ...
```

Since this converges absolutely, it converges when `x` is a complex number as well, and the differential equation still holds.

If `t` is real,

```
Re e(it) = 1 - t ** 2/2! + t ** 4/4! - ...
Im e(it) = t - t ** 3/3! + t ** 5/5! - ...
```

Because of that

so

```
1 = e(0) = e(i*t - i*t) = e(i*t) * e(-i * t) =
  = Re e(it) ** 2 + Im e(it) ** 2
```

In other words, if `t` is real,

```
||e(i*t)|| = 1
```

In other words, `e(i * t)` is a function from the real line to the unit circle.

```
Re e(2 * i) < 0
```

from a quick estimation. So there's a smallest number, q,

```
Re e(i * q) = 0
```

and because of that

```
Im e(i * q) = +/- 1
```

In other words,

```
e(i * q) = i
e(i * 4 * q) = i**4 = 1 = e(0)
```

Let's call `t = q * 4`, we have

```
e(x + i * t) = e(x) * e(i * t) = e(x)
```

So `e` is periodic, with a period of `i * t`. Pi is just `t / 2`.

In this argument, the function `e` does all the hard work. Pi just falls out of it as the period along the imaginary axis. Pi can't find `e`, but `e` can find Pi.

Pi is not wrong because it's half of Tau. Pi is wrong because it's a property of `e`, not the other way around.

Next time you want to memorize a number, memorize `e`.

CHAPTER 5

Jedi are Good, Actually

5.1 Why rant?

There's a persistent theme in Star Wars analysis to say that the Jedi are bad, because they spurn attachments. A good example of the arguments can be seen in film theory. I give that as an example not because it's a bad job, but because Matt is a careful thinker and researcher: this is one of the best researched examples of this.

Let's do away with one straw-man first: the Jedi being bad does not mean the Sith are right. You can definitely have two horrifyingly bad philosophies which leave destruction in their wake as their proponents fight.

This is not the argument I will make here. That the Sith are bad, and the Galactic Empire is an oppressive regime, cannot be disputed unless you go beyond mere "unreliable narrator". But that does not pertain to the central question: is the Jedi philosophy wrong-headed?

5.2 Jedi beliefs

First, what *is* the philosophy? The original trilogy has Yoda saying that anger, fear, and hate are contrary to it, but does not, on-screen, give any positive guidance. Anakin is a bit more specific in the prequels, talking about the fine line between *attachment* and *love*.

This led many to try to extrapolate incorrectly. My trusted source for Star Wars lore is Wookipedia, which details the Jedi code as:

- There is no emotion, there is peace.
- There is no ignorance, there is knowledge.
- There is no passion, there is serenity.
- There is no chaos, there is harmony.
- There is no death, there is the Force.

5.3 Space Buddhism

The principles of seeking peace, knowledge, serenity, harmony, and freedom from the fear of death, appear in a real life tradition: Buddhism.

Passion, desires, are identified in Buddhism as the source of pain. When the passion is overcome, there is no more pain. Through meditation, it teaches how to see emotions as something one *feels*, separate from a sense of self. This is close to "there is no emotion, there is peace".

Indeed, there is a real-life temple where people study both the philosphy of Buddhism and is committed to training adherents in martial arts: the Shaolin Temple. The temple has not been politically neutral: much like the Jedi, it has served as support for the stability of China.

5.4 Jedis as peace-keepers

The Jedi commitment to harmony, peace, and forgoing attachments was critical to public faith in the even-handedness of the Jedi. This is why Jedi are taken, *with the consent of their families*, to train in the Jedi temple in Coruscant. This allows the Jedi to act as representatives of the Republic as a whole, not their planet of origin.

It is important to note here that nowhere is it implied that the Jedi pressure families to give up their kids, any more than they are honest with the truth: after attachments have been formed, it is dangerous to train someone, force-sensitive though they may be, into the Jedi order. Indeed, Yoda and the council suggested Anakin be returned to his mom rather than trained. The council is fine with allowing kids who are strong in the force to stay with their families, but these kids will not grow up to become Jedis.

5.5 Fall of the Jedi

So, if the Jedi are not horribly corrupt, what was the cause of the downfall of the Jedi order? Arrogance on the part of the Jedi was certainly a part of it. But let's also remember that the Sith have infiltrated the Republic, and staged a galactic war: the so-called "Clone Wars". In these conflicts, the Jedi, originally trained as peace-keepers and negotiators, were drafted as generals. Why did they accept the position? At the time when the clone wars started, the Republic had no standing army. The clone troops were trained as soldiers and tactical commanders, not as high-level officers.

Part of the reason for this lack of standing military was manipulation by the Sith. The Republic needed people who could gain the trust of the clone troopers, and could lead them in battle. The combination of Jedi arrogance and lack of viable alternatives played into the hand of the careful plan by the Sith.

The Jedi order, distracted by the war, clouded by the dark side, and naively extrapolating from centuries assuming the Sith were not a serious threat, was blind-sided. Qui-Gon Jin, who would have foresaw this, was assassinated. Indeed, the entire plot of the Phantom Menace was probably to get rid of Qui-Gon.

The Jedi order did not fall because their philosophy was a bad philosophy, and did not rise again because it did away with this philosophy. It fell because it was arrogant, lulled into complacency, and carefully manipulated.

5.6 Is passion good?

There are those who defend the Sith creed, "Through Passion I gain Strength". Having worked in an industry where the word "passion" was used to manipulate people, I have seen first-hand the evils of the Sith philosophy. Fighting with passion, giving into the hate, means not caring about collateral damage. This is not a good attitude, though it can be, unfortunately, a *successful* attitude.

CHAPTER 6

Leap Seconds

6.1 Time is political

I am a time-measurement geek. Time measurement is a fascinating topic, and I can talk about it for hours. One of the most fascinating aspects is just how *political* it gets.

Measurement is always political. The French revolution lopped off heads and invented the metric system. But time measurement is even more political than most. Indeed, time zones are so complicated politically that the official designation is `Continent/City` (for example, `Asia/Taipei`) so that when naming the time zone, nobody has to argue about whether Taiwan exists.

Much like this example shows, the politics around time are not always, or even often, along the right/left spectrum. Nonetheless, where humans meet and have to make joint decisions, politics exists.

6.2 What is a leap second?

Take a specific point on earth that is relatively stable. For example, Disney World's Mission: Space attraction. If you drew an imaginary line from the center of the earth to the center of the Mission: Space attraction, which way would it face at midnight? Let's say you put a telescope, align it with this line, and take a picture every midnight.

Earth moves, the galaxy moves, and the pictures will be slightly different every night. However, you assume it faces the same "way", and that those pictures tell you a story about the relative movement of the earth and the stars.

However, the earth spinning around its axis can take slightly longer or shorter than 24 hours. The rotation of the earth is influenced by the moon, geologic events, and other hard-to-predict phenomena. Because of this, if the imaginary line we drew is off by more than 1/86,400, a second will be added to compensate. This is not done by an algorithm, this is done by a committee of scientists. Nothing can predict that: you can only know about the next leap seconds a few months ahead of time and prepare your system in an ad-hoc way.

6.3 Why a leap second?

Astronomers and astrophysicsts need to carefully measure things in the sky. Being off by 1/86,400 would mean some of our important research would be impossible to do, because the data would be too noisy. Similarly, space missions need to be able to accurately identify locations in space.

In total, from 1972 to 2021, a total of 27 leap seconds were announced. At the beginning of this process, an extra 10 "leap seconds" were introduced for initial alignment. Counting liberaly, in the last 50 years, less than 40 leap seconds have been introduced.

6.4 What's the big deal?

Astrophysicsts and astronomers are not the only ones who care about time. For some applications, having an unpredictable day with an extra second could wreak havoc with results. Even if the results are not important, needing to align many measurement devices with an ad-hoc heads-up causes extra churn for anyone who needs time synchronization.

Since nobody wants to mess around with sattelites in orbit, GPS time is not modified by leap seconds. GPS time is currently ahead of UTC (the time standard that takes leap seconds into account) by 18 seconds. TAI and Loran-C, two other international efforts to measure time, are also not modified by leap seconds, and are currently 37 and 27 seconds ahead of UTC.

Even though GPS, TAI, and Loran-C times are different, the difference between them can be specified by an algorithm. The algorithm is comically simple: just add or subtract a constant (10, 19, or 9, depending on which one to which one). In contrast, converting UTC to those times cannot be done with an algorithm. For past times, an algorithm exists (but is complicated) and for future times, it is unknown.

6.5 What about my phone?

If you are a modern person, you probably own a smartphone with a GPS receiver. The GPS receiver gets the position, but also the current time, from the satelites. Modern phones also use the network to synchronize time: NITZ for 3G, and NTP for modern smartphones. For example, Android uses `2.android.pool.ntp.org` by default (although manufacturers will sometimes modify the server.)

NTP time, and NITZ time, uses UTC. This means that smartphones all have *two* notions of time: GPS time and UTC time. Because of astrophysicists and astronomers, less than 0.01% of the human race, all users smartphones (roughly 50% of the human race) have to have two different timekeeping devices in their pockets.

6.6 More issues

As wikipedia notes, randomly adding seconds to days causes problems for a lot of things. The "common workaround" is to use TAI internally, which would be great if not for the fact that the most common time-sync protocol is defined by UTC.

6.7 Are leap seconds evil?

Leap seconds represent a cost to more-or-less all people for the benefit of 0.01%. Astronomy and astrophysics benefit all people, but this sort of "trickle-down economics" is normally frowned upon. We usually ask people to bear the costs of their own needs, and offer to support them with resources, not global sacrifices, if we think their cause is just. Taxing all people for the benefit of the 0.01% is evil by any reasonable ethical system.

There are no two sides. Leap seconds are evil.