



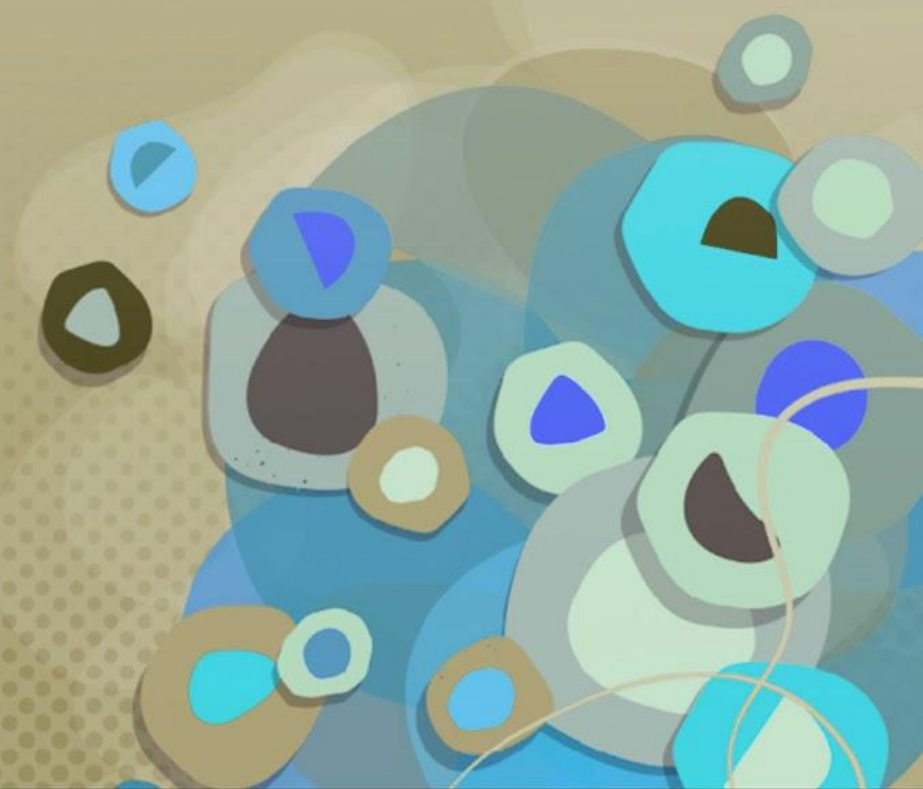
March 20-24, 2023  
San Francisco, CA

✓ Random Number  
Generators

# Cards, Dice & RNGs: Using Randomness Intentionally

Design talk by Randy Smith  
Waves All Day *(that's my new studio)*  
[geminiradio@gmail.com](mailto:geminiradio@gmail.com)

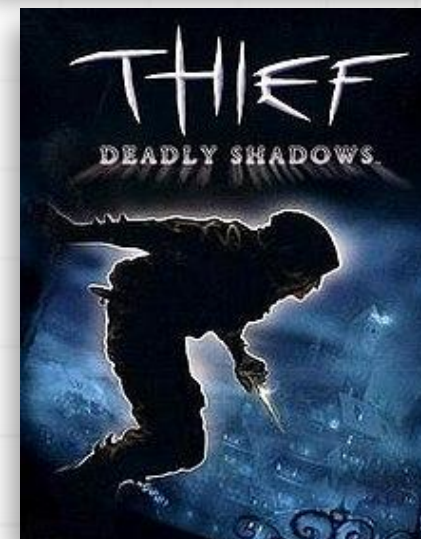
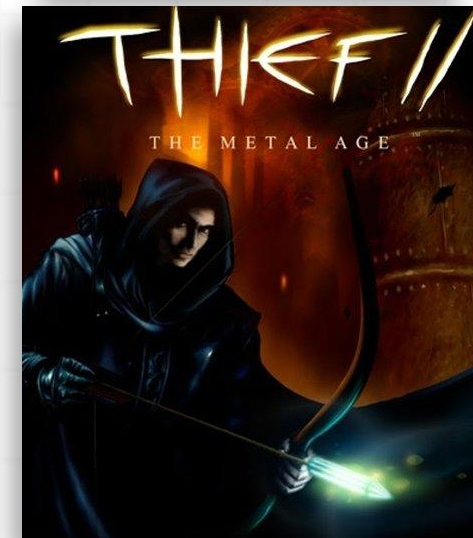
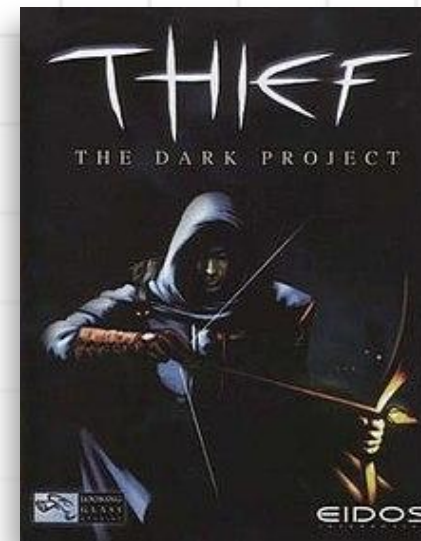
#GDC23





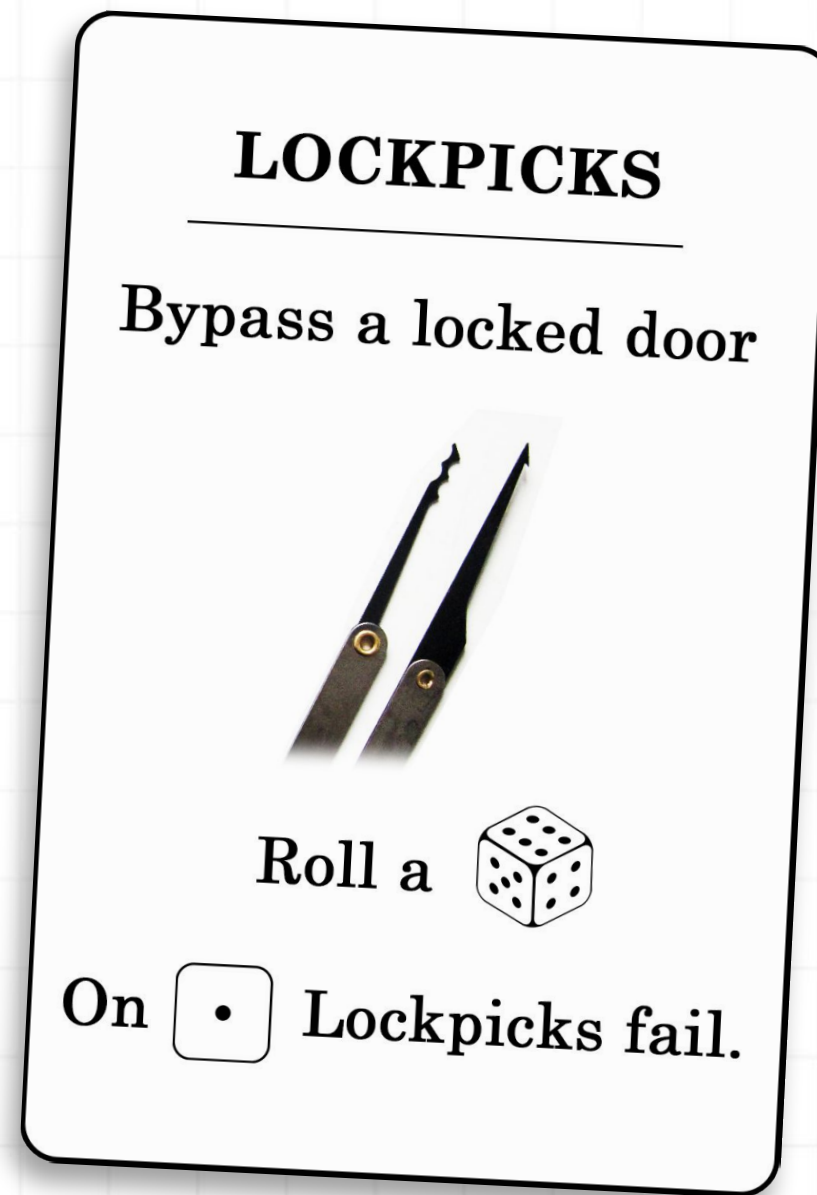
# Randy Smith

- ♣ Designer / Director
- ♣ *Thief* series
- ♣ Ubisoft, EA, Hollywood
- ♣ Indie studio Tiger Style
- ♣ *JETT: The Far Shore*
- ♣ Current: Digital games with tabletop-like mechanics





# My Randomness Journey





# This Talk

- ♣ How randomness works
  - ♣ Survey of mechanics
  - ♣ Tools to manage randomness
  - ♣ Purpose of randomness in game design
- 
- ♣ Outline: Dice, then Cards





# Why Probability Is Important

- ♣ Randomness creates the contours of your gameplay
- ♣ Players will solve for those contours
- ♣ There may also be imbalances
- ♣ Probability math can reveal these properties without lots of testing, trial and error





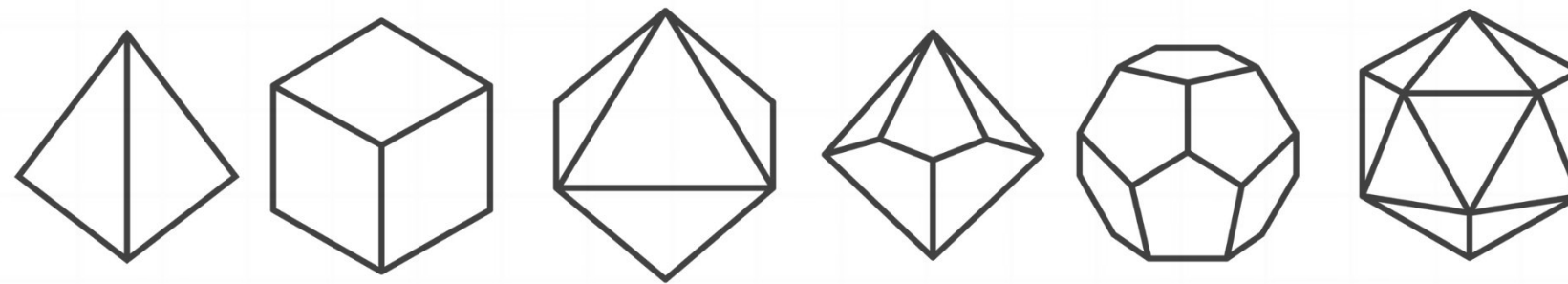
# Uncertainty

- ♣ Randomness
- ♣ Other players
- ♣ Not-yet-known content or mechanics
- ♣ State space too large / Systemic complexity
- ♣ Hidden information

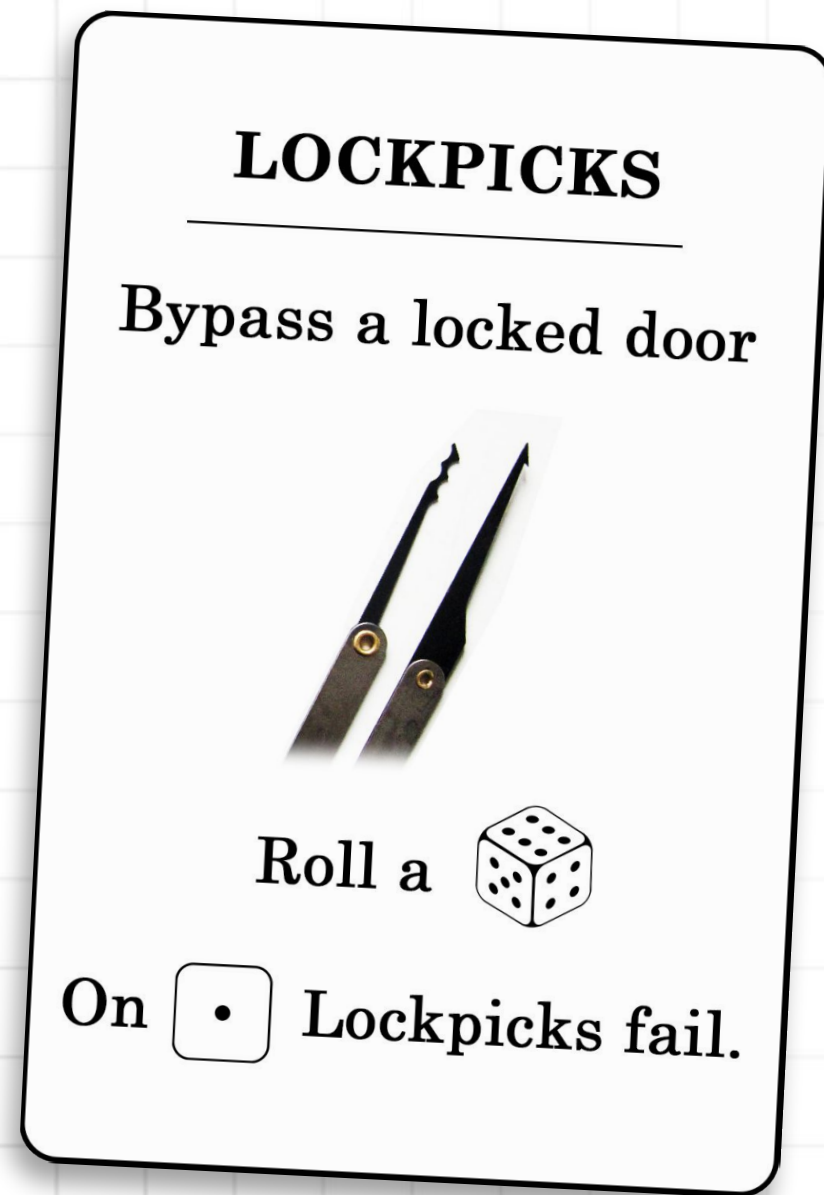




# *Part 1: Dice*



# Aesthetics of this Die Roll?

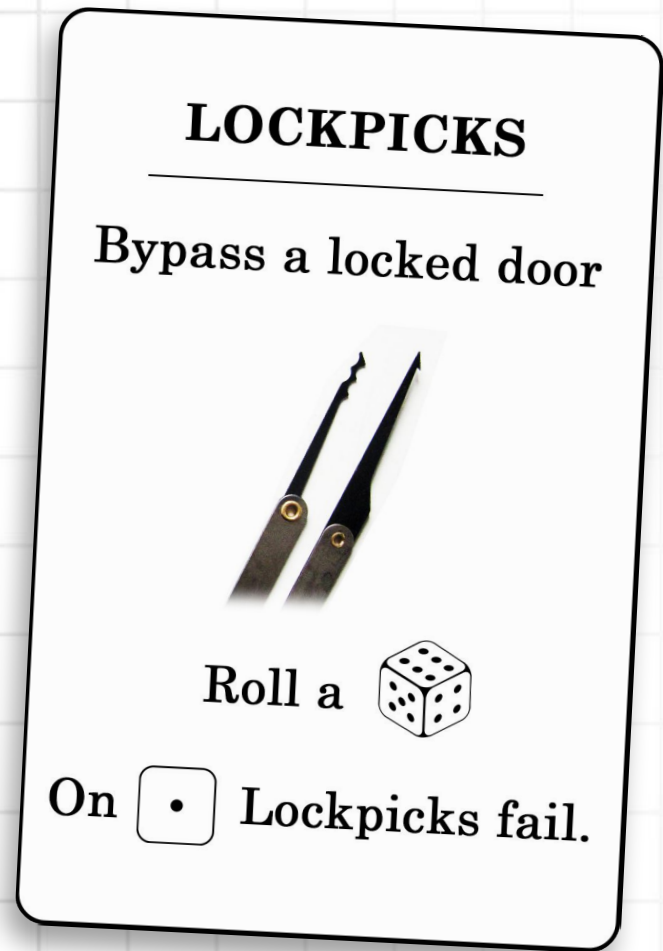


- ♣ Drama!
  - ♣ Celebration / Victory
  - ♣ Frustration / Failure
- 
- ♣ What was the player supposed to do if they roll a 1?





# Combat To-Hit Rolls



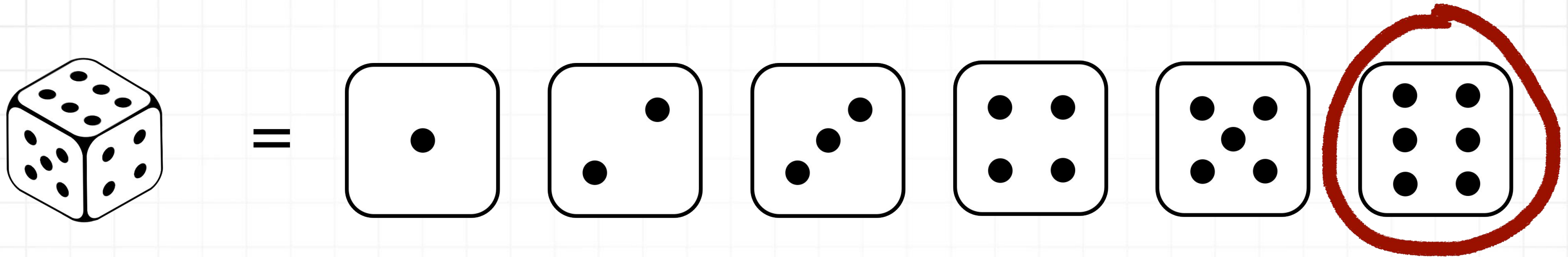
vs.





# Probability with one die

*"Roll a six."*



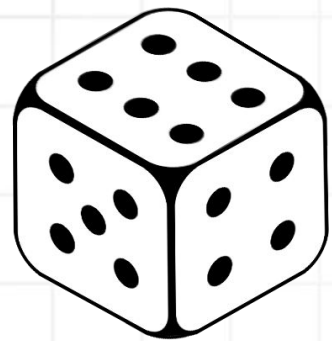
$$\frac{1}{6} = 16.\overline{6}\%$$



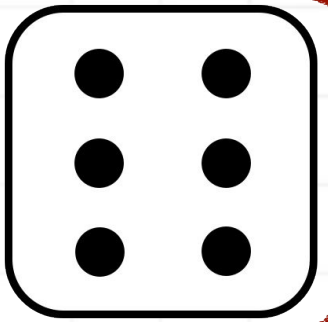
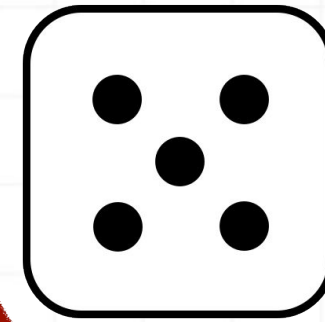
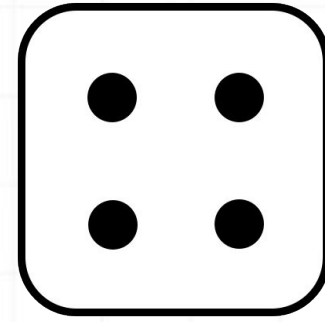
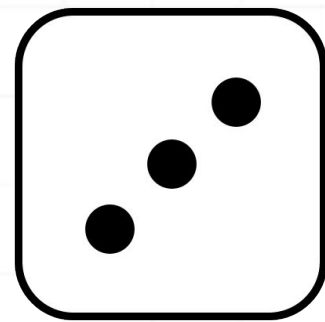
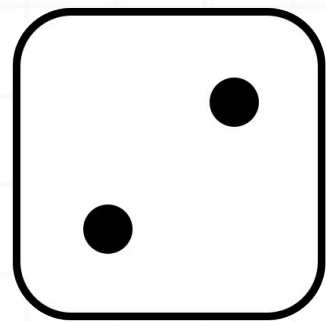
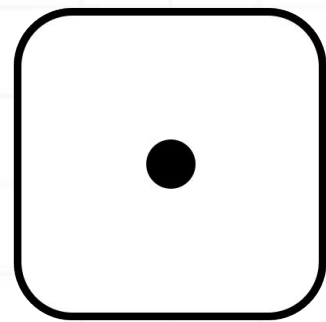


# Probability with one die

*"Roll a five (or higher)."*



=



$$\frac{2}{6}$$

=

$$\frac{1}{3}$$

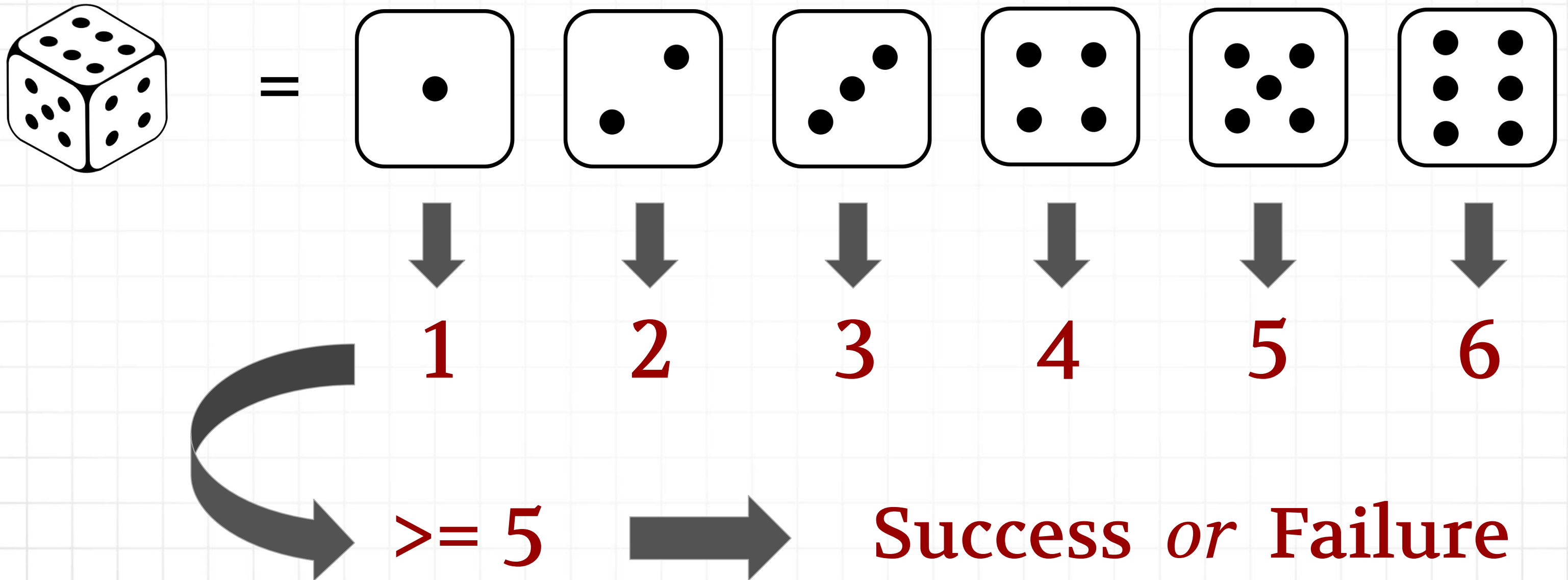
=

$$33.\overline{3}\%$$



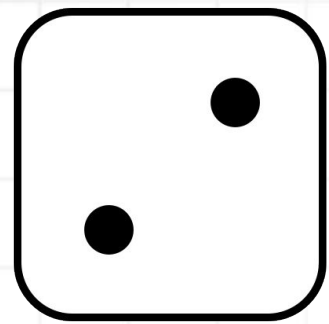
# Mapping

*“Roll a five (or higher).”*

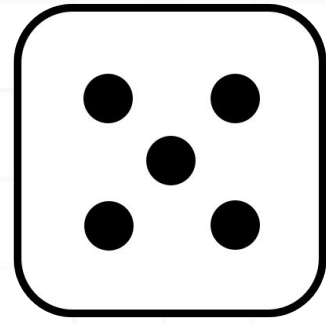




# Mapping



2



+

5

=

7

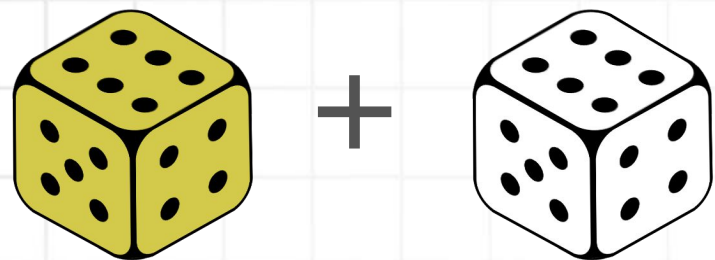


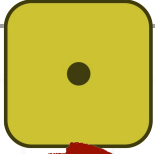
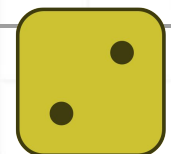
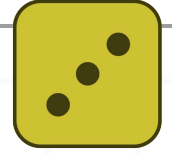
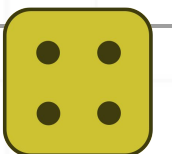
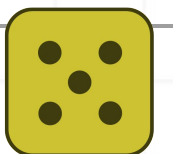
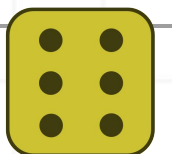
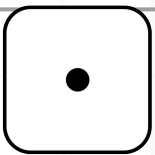
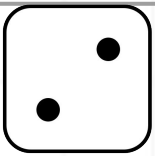
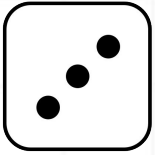
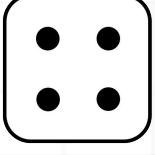
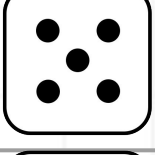
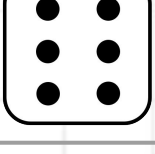
some game  
mechanic

*“Add two dice.”*



# Aggregate: Adding two dice

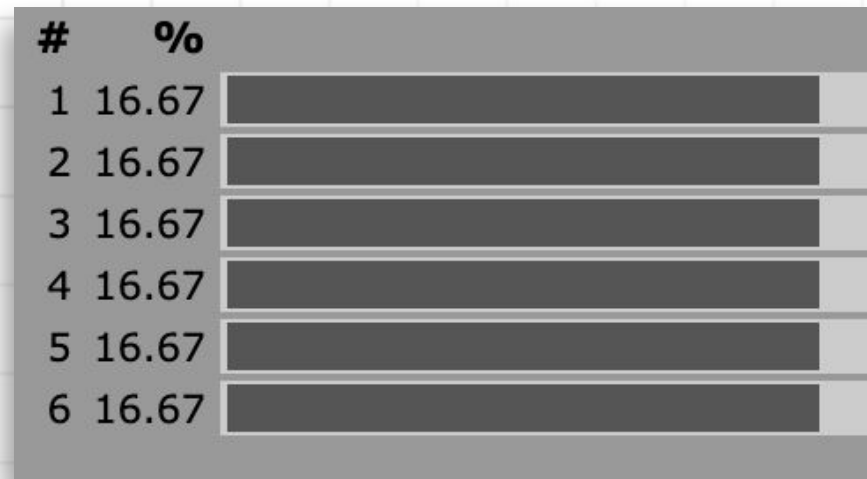



|   |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
|    | 2   | 3   | 4   | 5   | 6   | 7   |
|   | 3   | 4   | 5   | 6   | 7   | 8   |
|  | 4   | 5   | 6   | 7   | 8   | 9   |
|  | 5   | 6   | 7   | 8   | 9   | 10  |
|  | 6   | 7   | 8   | 9   | 10  | 11  |
|  | 7   | 8   | 9   | 10  | 11  | 12  |

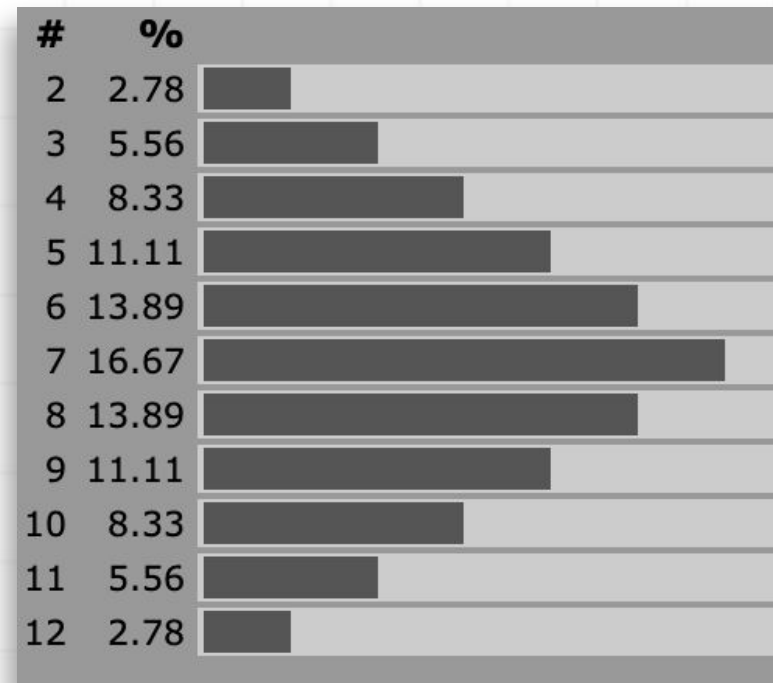




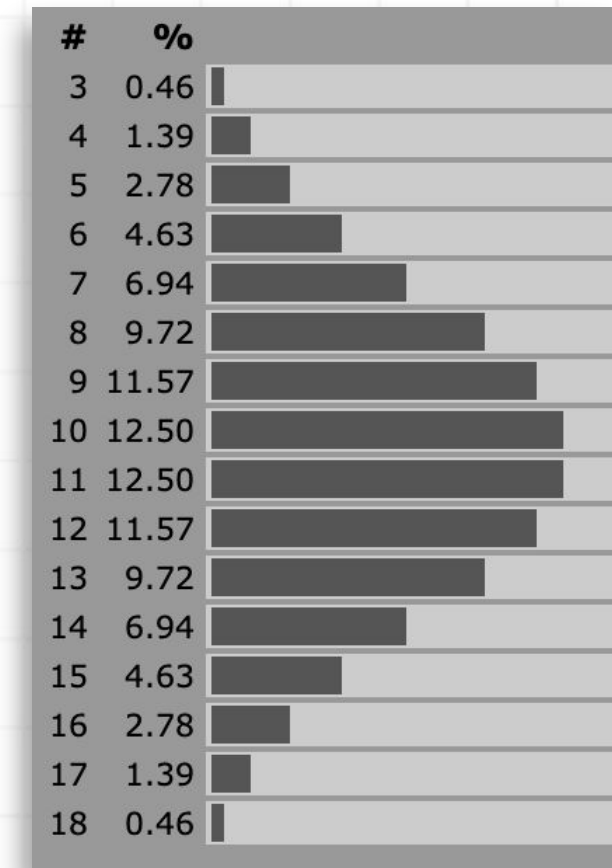
# Distributions



  
**Flat**

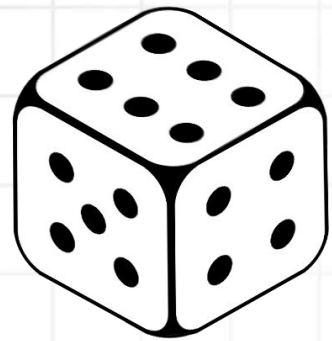


  
**Pyramid**

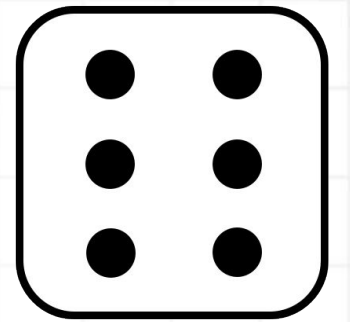
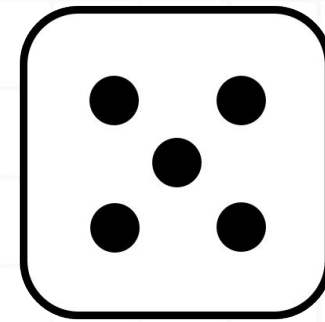
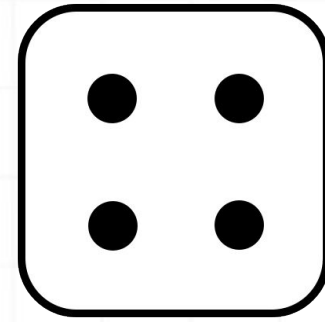
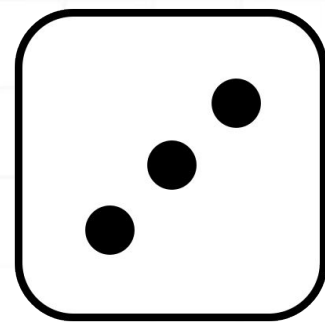
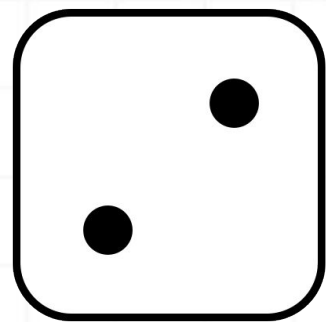
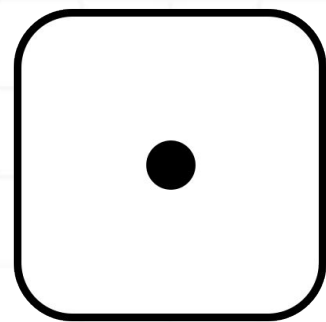


  
**Bell Curve**

# Expected Value



=



1 + 2 + 3 + 4 + 5 + 6

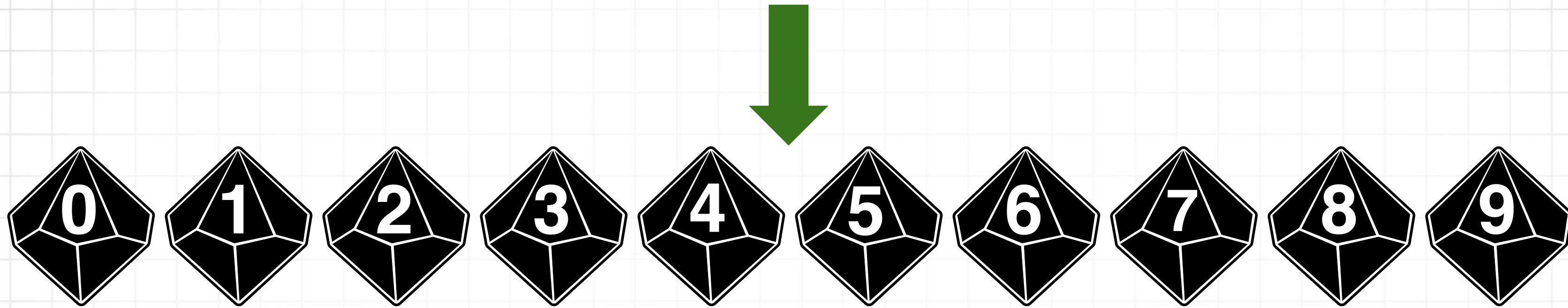
= 21 ÷ 6



3.5



# Expected Value



$$0 + 9 \div 2$$


$$4.5$$

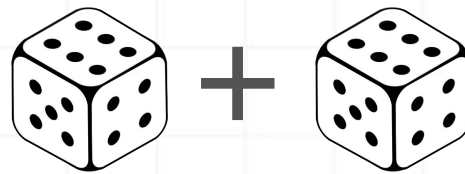




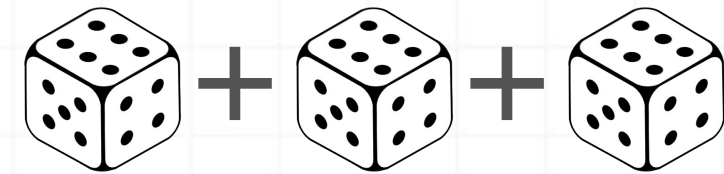
# Expected Value of Pool of Dice



3.5



$3.5 + 3.5 = 7$



$3.5 + 3.5 + 3.5 = 10.5$



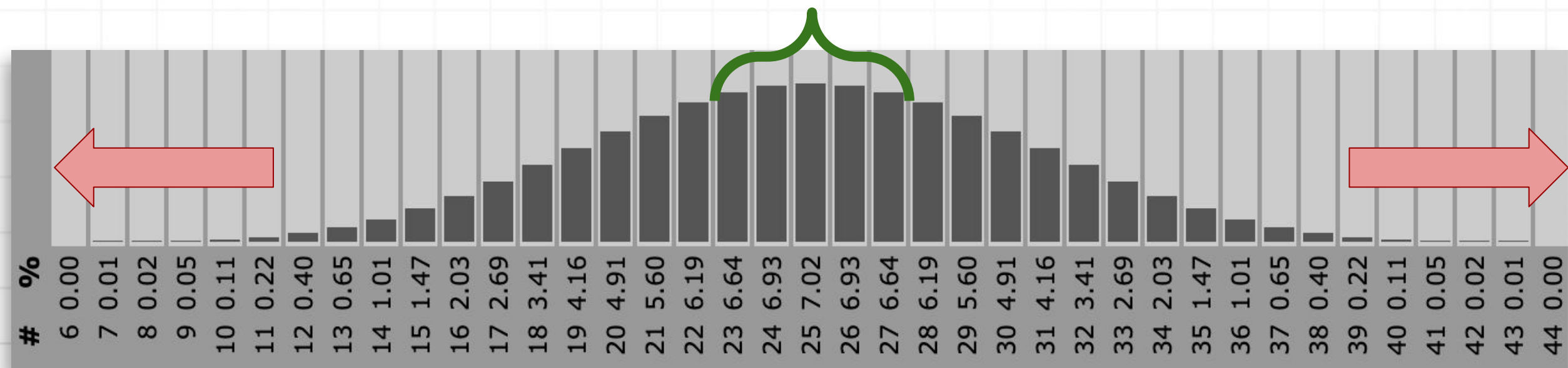
# Big Dice Pools “d4 + 2d6 + 2d8 + d12”



$$1 + (2 * 1) + (2 * 1) + 1 = 6$$

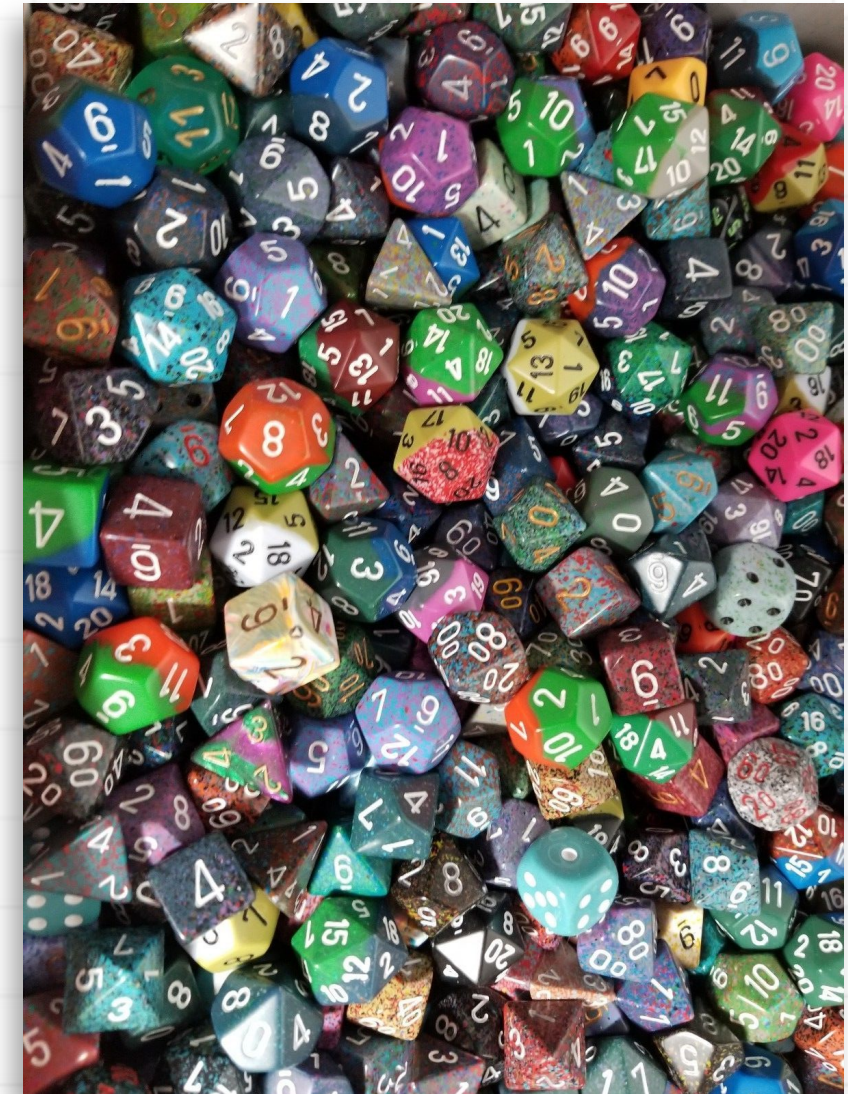
$$2.5 + (2 * 3.5) + (2 * 4.5) + 6.5 = 25$$

$$4 + (2 * 6) + (2 * 8) + 12 = 44$$



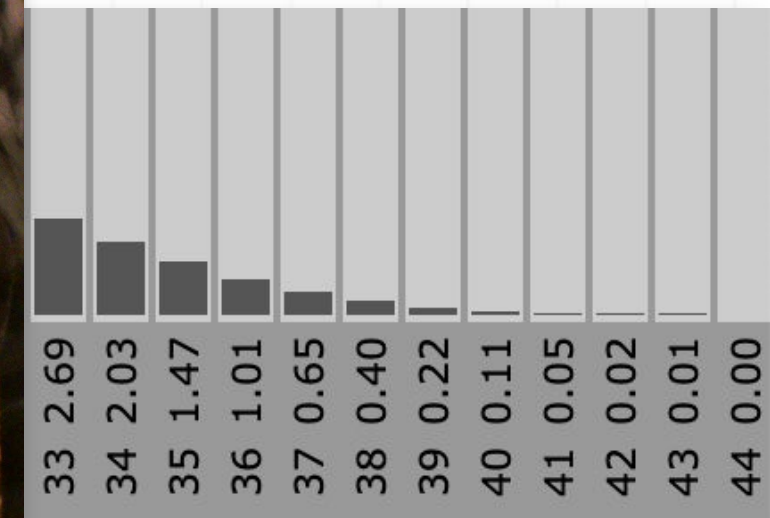
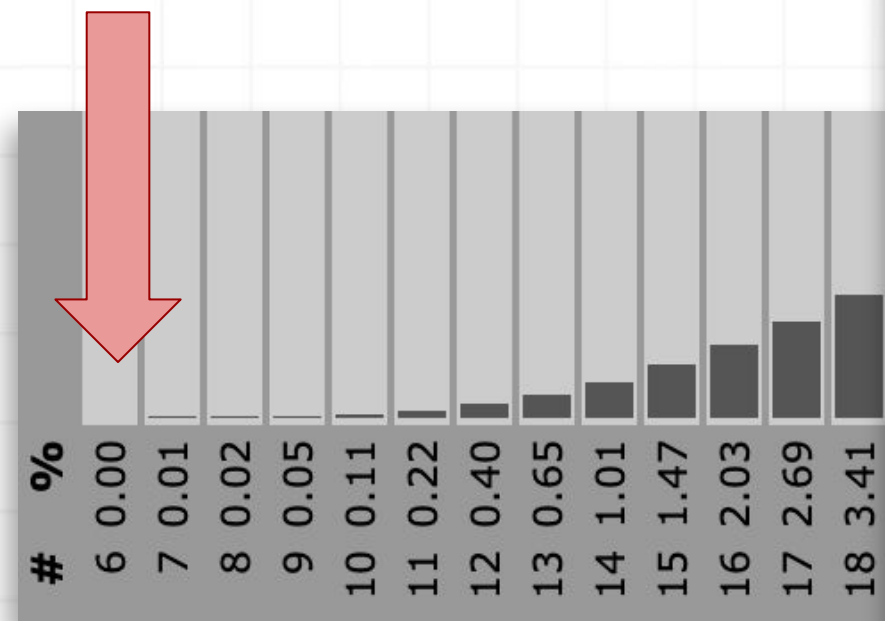


# To-Hit Rolls = Aggregate





# Extremely Rare Events Sometimes Happen



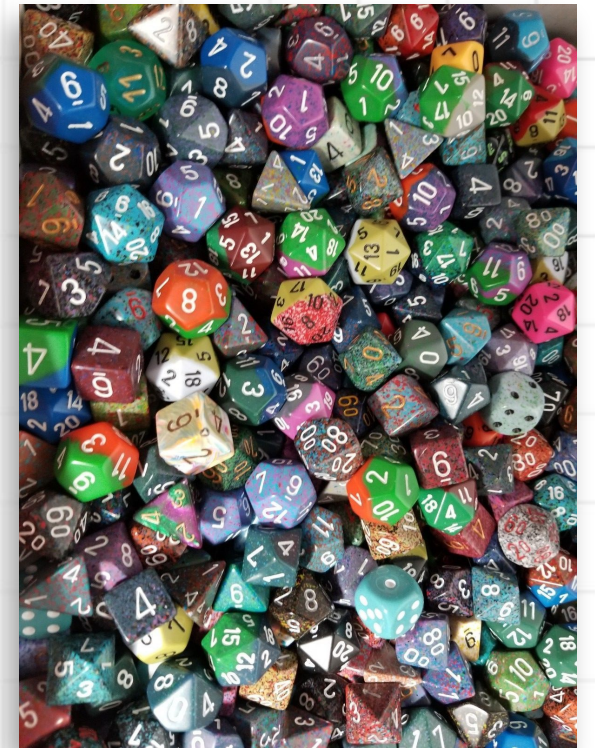
Worst possible outcome  
 x 1M players  
 0.0009%)  
 0 times





# More Aggregate → Vanishing Odds of Extreme Events

48d6  
(Min = 48)

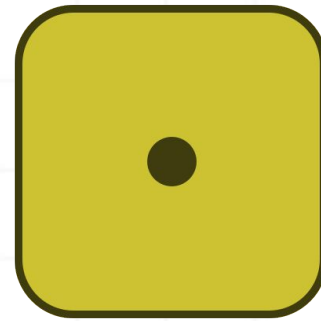


Any outcome less than 90  
x 10T playthroughs = 1 times

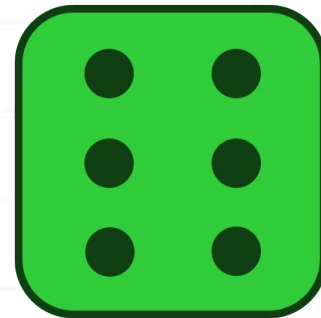




# Swinginess



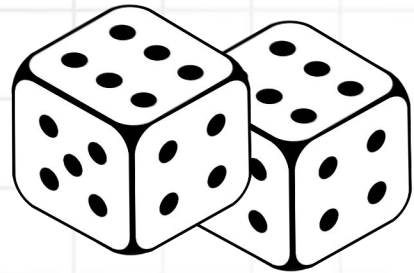
**\$100**



**\$600**



# Swinginess of d6

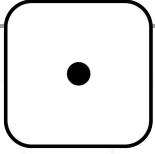
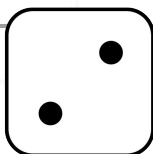
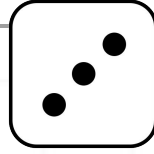
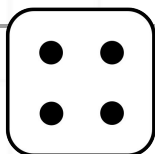
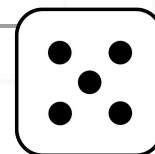
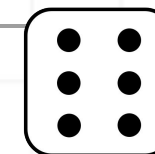
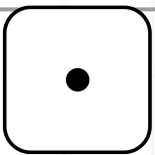
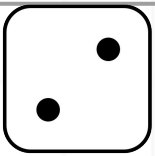
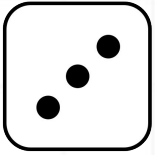
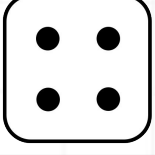
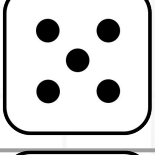
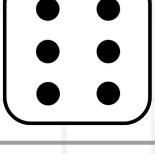


are two  
results  
off by  
3x or  
more?

**10/36**

**=**

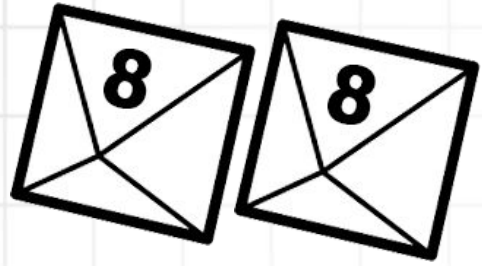
**27.7%**

|   |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
|    |   |   |   |   |   |   |
|   |   |   |   |   |   |   |
|  |   |   |   |   |   |   |
|  |   |   |   |   |   |   |
|  |   |   |   |   |   |   |
|  |   |   |   |   |   |   |





# Swinginess of d8



are two  
results  
off by  
3x or  
more?

**18/64**

**=**

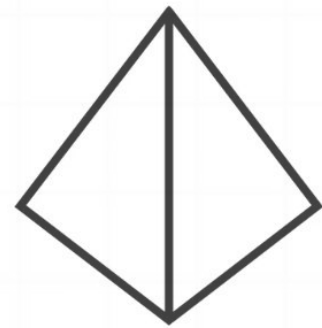
**28.1%**

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 |   |   |   |   |   |   |   |   |
| 2 |   |   |   |   |   |   |   |   |
| 3 |   |   |   |   |   |   |   |   |
| 4 |   |   |   |   |   |   |   |   |
| 5 |   |   |   |   |   |   |   |   |
| 6 |   |   |   |   |   |   |   |   |
| 7 |   |   |   |   |   |   |   |   |
| 8 |   |   |   |   |   |   |   |   |

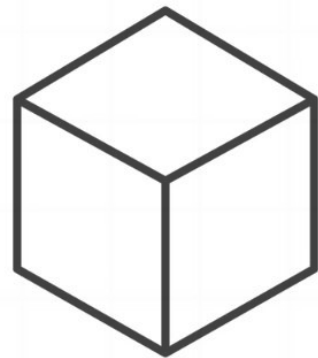


# Swinginess

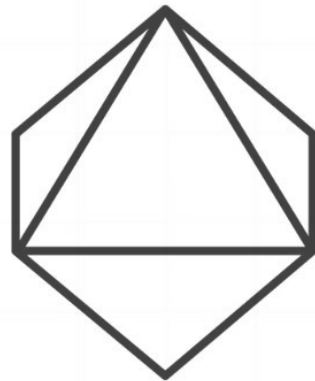
as measured by how frequently it produces adjacent results that are off by 3x or more



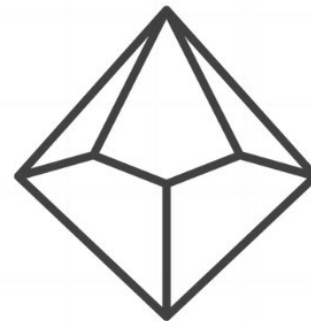
25%



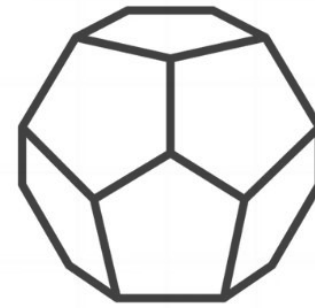
28%



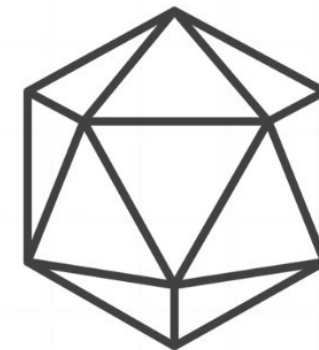
28%



30%



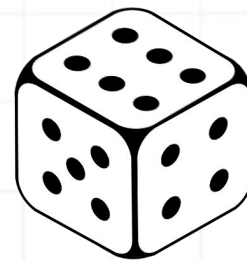
31%



32%



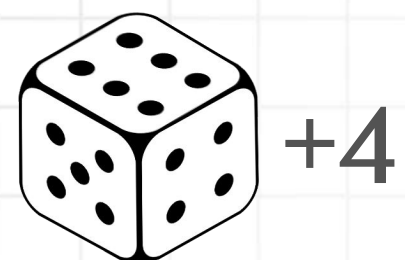
+



7.5%



# Swinginess of d6+4



are two  
results  
off by  
3x or  
more?

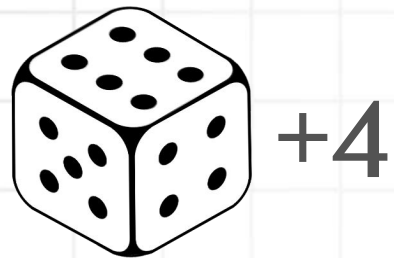
0/36  
=  
0%

|    | 5 | 6 | 7 | 8 | 9 | 10 |
|----|---|---|---|---|---|----|
| 5  |   |   |   |   |   |    |
| 6  |   |   |   |   |   |    |
| 7  |   |   |   |   |   |    |
| 8  |   |   |   |   |   |    |
| 9  |   |   |   |   |   |    |
| 10 |   |   |   |   |   |    |





# Swinginess of d6+4



are two  
results  
off by  
2x or  
more?

**2/36**

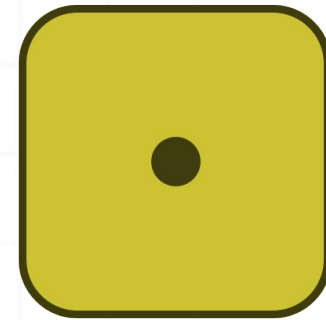
**=**

**6%**

|    | 5 | 6 | 7 | 8 | 9 | 10 |
|----|---|---|---|---|---|----|
| 5  |   |   |   |   |   |    |
| 6  |   |   |   |   |   |    |
| 7  |   |   |   |   |   |    |
| 8  |   |   |   |   |   |    |
| 9  |   |   |   |   |   |    |
| 10 |   |   |   |   |   |    |



# Importance of Events



\$100



\$600





# Event Weight in *Exocolonist*



Sarah  
Northway  
of *Rebuild*,  
*Exocolonist*,  
etc.

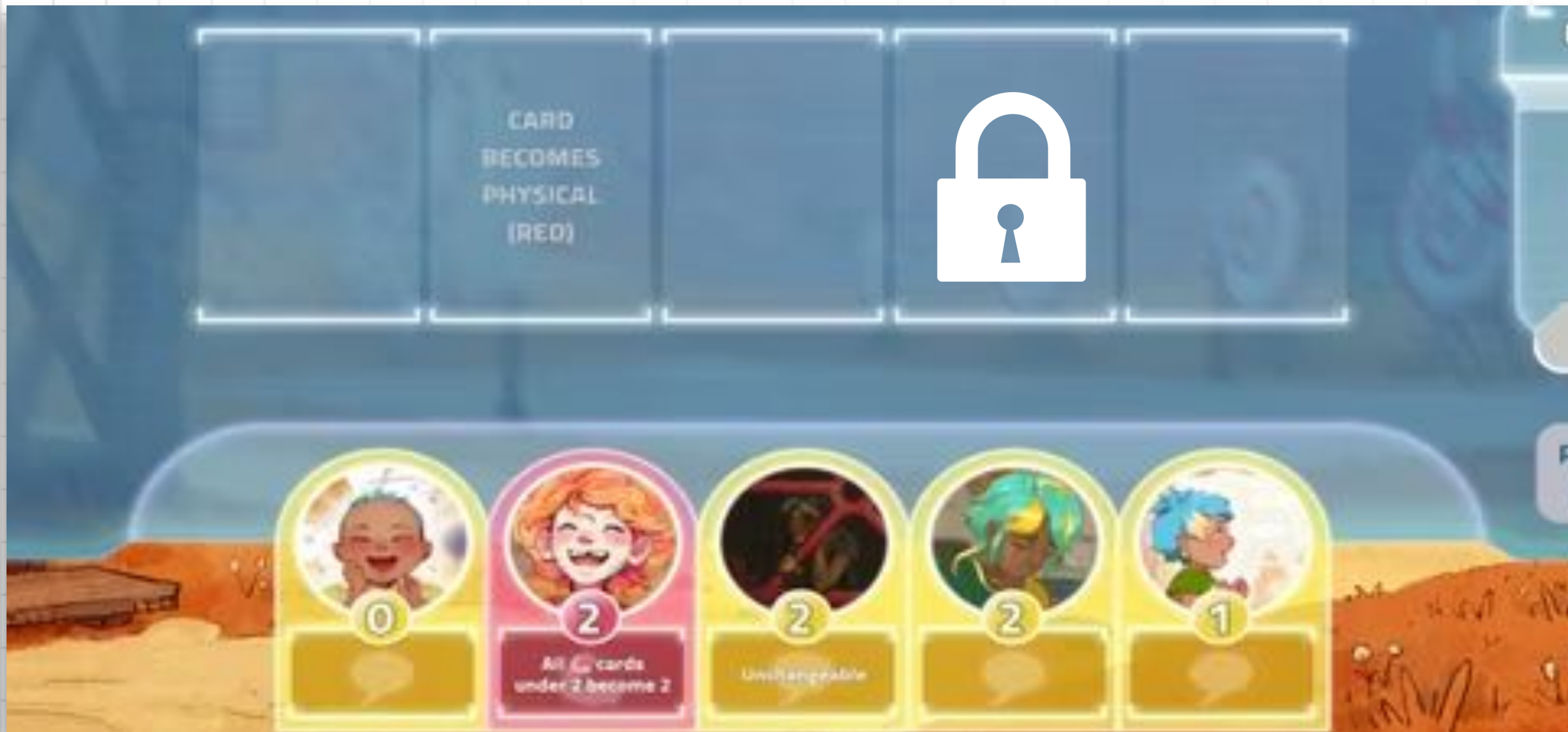




# Event Weight in *Exocolonist*



Sarah  
Northway  
of *Rebuild*,  
*Exocolonist*,  
etc.



# Event Weight in *Exocolonist*

“...walk a line between fun randomness and frustrating randomness, and hide our manipulation so players don't feel too coddled.”



Sarah  
Northway  
of *Rebuild*,  
*Exocolonist*,  
etc.





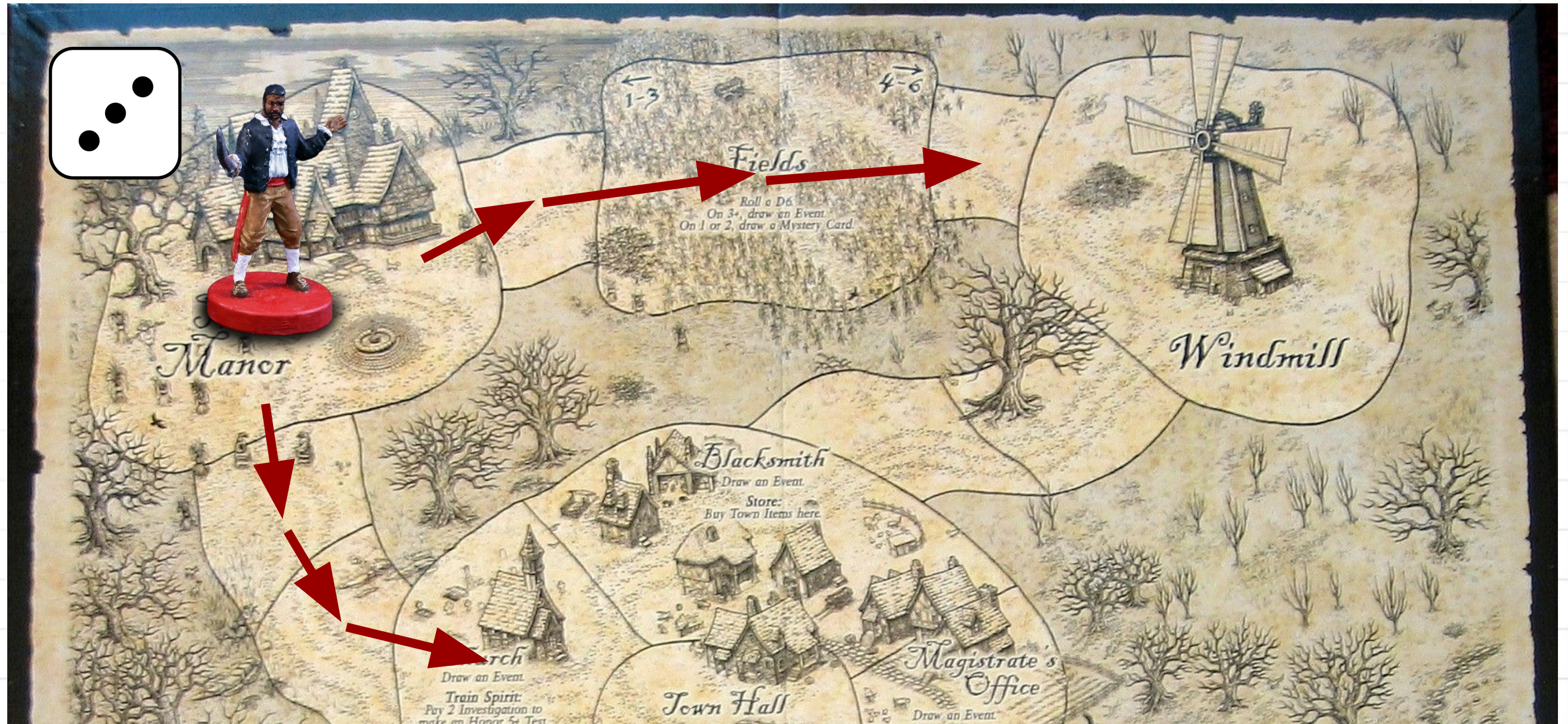
# Takeaways So Far

- ♣ Aggregate Randomness Leads to More Predictability
- ♣ Isolated Random Events Are More Swingy  
(one die = max swinginess)
- ♣ Very Rare Events Sometimes Happen
- ♣ Be Conscious of Events With More Importance/Weight



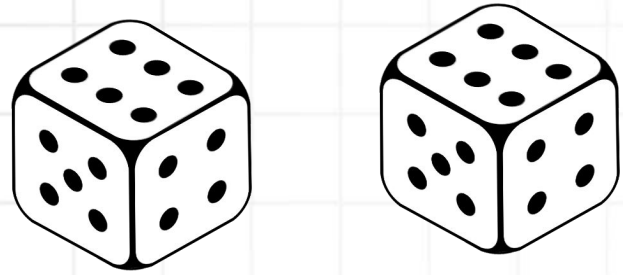


# Area Movement in *Touch of Evil*



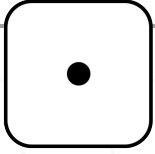
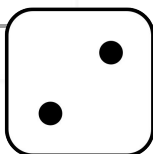
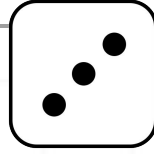
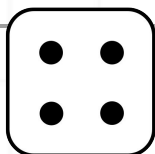
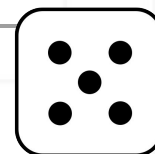
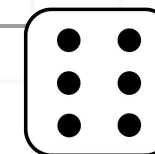
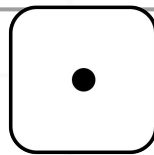
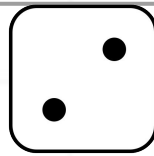
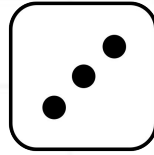
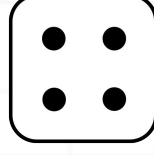
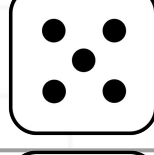
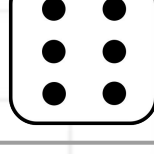


# Area Movement in *Touch of Evil*



shake 3 or less total  
after 2 rolls

$$\frac{3}{36} = 8\%$$

|   |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
|    | 2   | 3   | 4   | 5   | 6   | 7   |
|   | 3   | 4   | 5   | 6   | 7   | 8   |
|  | 4   | 5   | 6   | 7   | 8   | 9   |
|  | 5   | 6   | 7   | 8   | 9   | 10  |
|  | 6   | 7   | 8   | 9   | 10  | 11  |
|  | 7   | 8   | 9   | 10  | 11  | 12  |





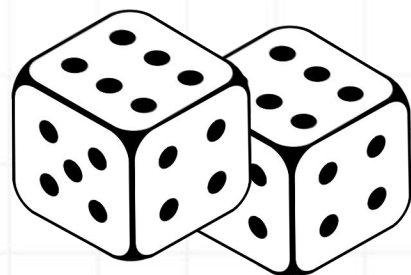
# Mods to Movement Rules



---

5

---



choose  
one



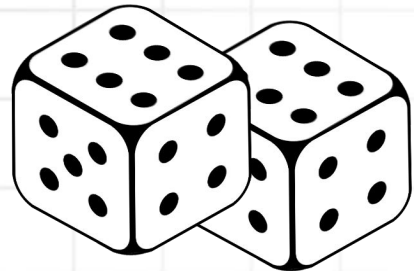


# Player Choice



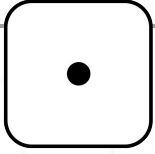
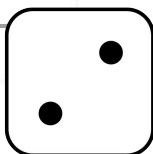
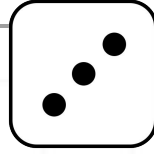
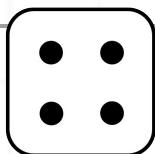
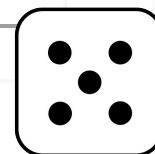
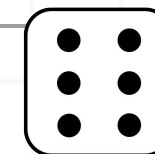
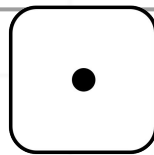
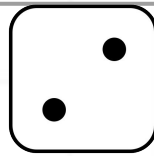
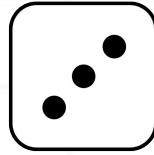
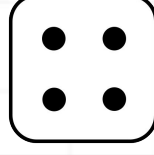
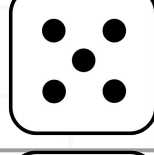
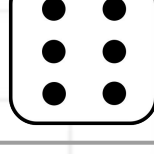


# 2-Choose-1



choose  
the  
highest

$$\frac{27}{36} = 75\%$$

|   |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
|    | 1   | 2   | 3   | 4   | 5   | 6   |
|   | 2   | 2   | 3   | 4   | 5   | 6   |
|  | 3   | 3   | 3   | 4   | 5   | 6   |
|  | 4   | 4   | 4   | 4   | 5   | 6   |
|  | 5   | 5   | 5   | 5   | 5   | 6   |
|  | 6   | 6   | 6   | 6   | 6   | 6   |



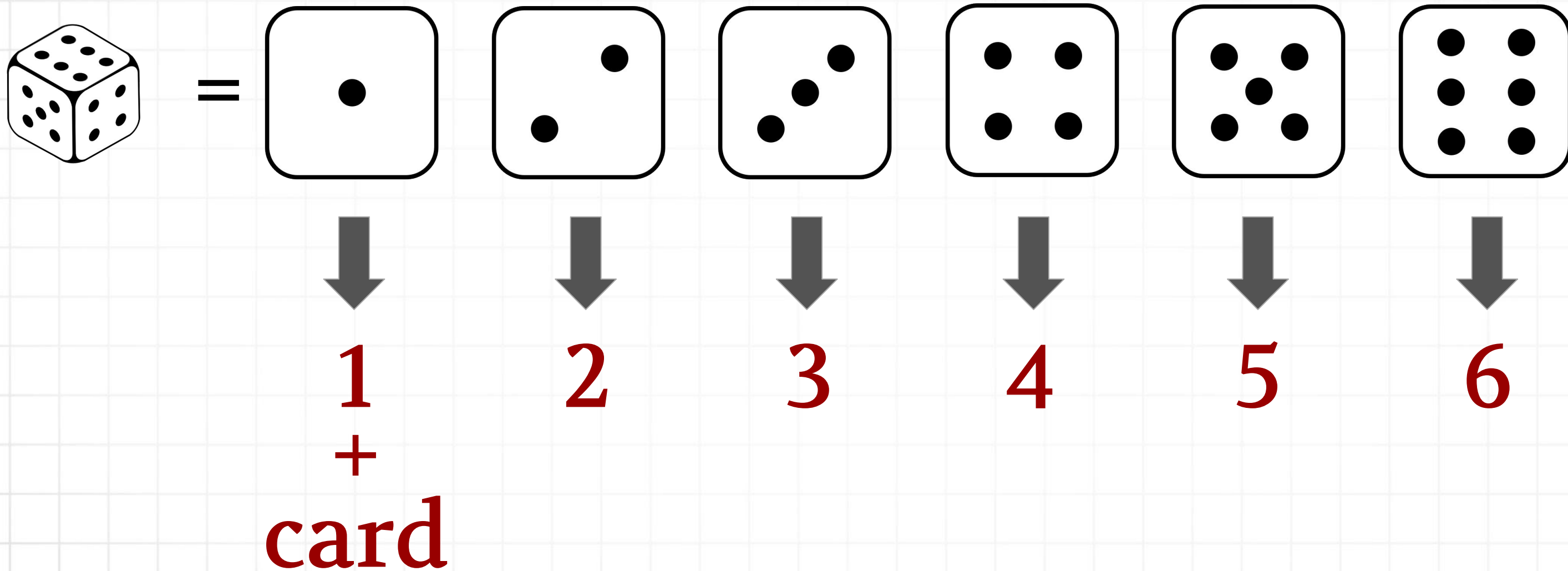


# Rolling a 1 in *Touch of Evil*

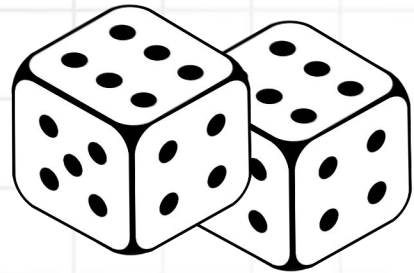




# Expected Value



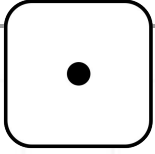
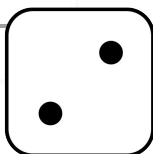
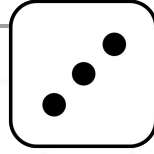
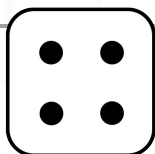
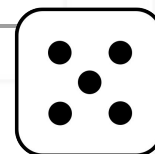
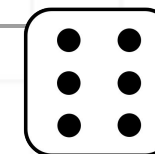
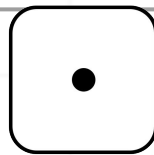
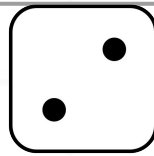
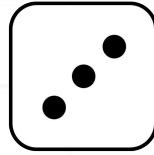
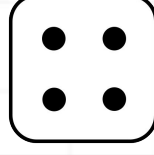
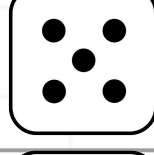
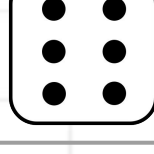
# Adding player choice



choose  
one

offers choice between 1  
(card) and 2-6

$$\frac{10}{36} = 27.8\%$$

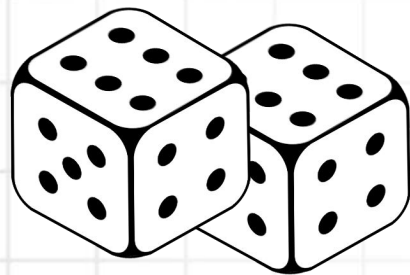
|   |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
|    | 1   | 2   | 3   | 4   | 5   | 6   |
|   | 2   | 2   | 3   | 4   | 5   | 6   |
|  | 3   | 3   | 3   | 4   | 5   | 6   |
|  | 4   | 4   | 4   | 4   | 5   | 6   |
|  | 5   | 5   | 5   | 5   | 5   | 6   |
|  | 6   | 6   | 6   | 6   | 6   | 6   |





# Aesthetics of these 2 mods?

5



choose  
one





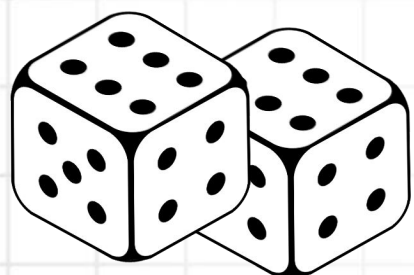
# Tilting The Playing Field Can Be Good





# Aesthetics of these 2 mods?

5



choose  
one





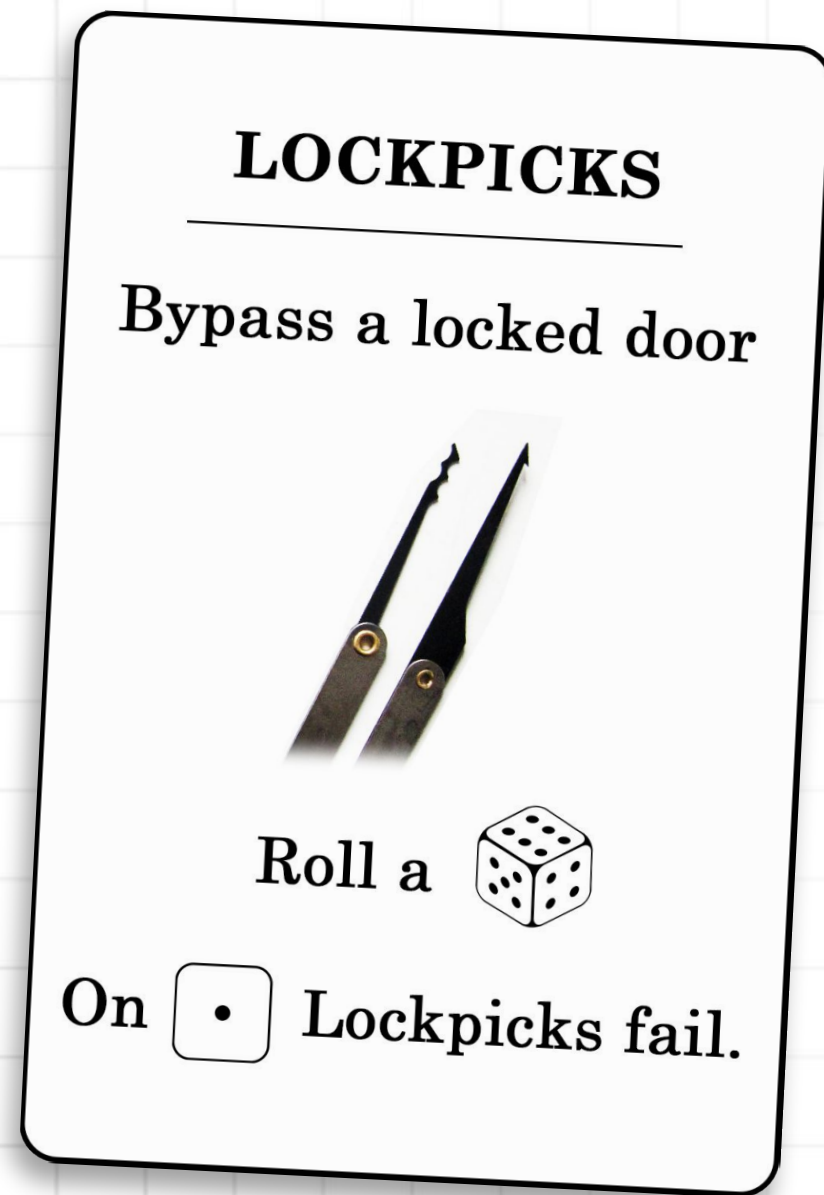
# Uses for Randomness

- ♣ Drama (*celebration, frustration*)
- ♣ Tilts the playing field, dilutes player skill contribution
- ♣ Defeats player planning
- ♣ Planning → Improvisation
- ♣ ...





# Psychology of Swinginess



- ♣ What if it fails on 1 in 2 instead?
- ♣ What about 1 in 10?
- ♣ 1 in 6 may be the worst odds in terms of psychology versus actual math



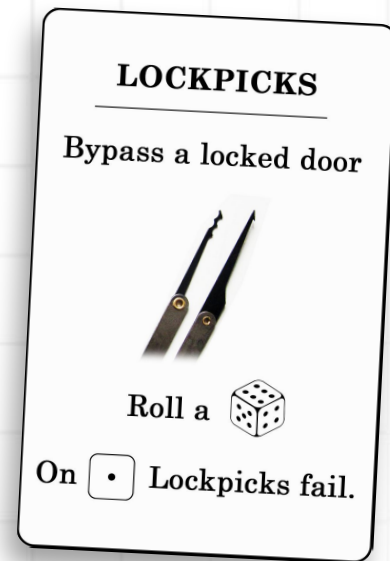
# Tentacle Token in *Arkham Horror LCG*



- ♣ Players commit resources to try to pass tests
- ♣ Then draw a token
- ♣ Tentacle token = auto fail



# Tentacle Token in *Arkham Horror LCG*



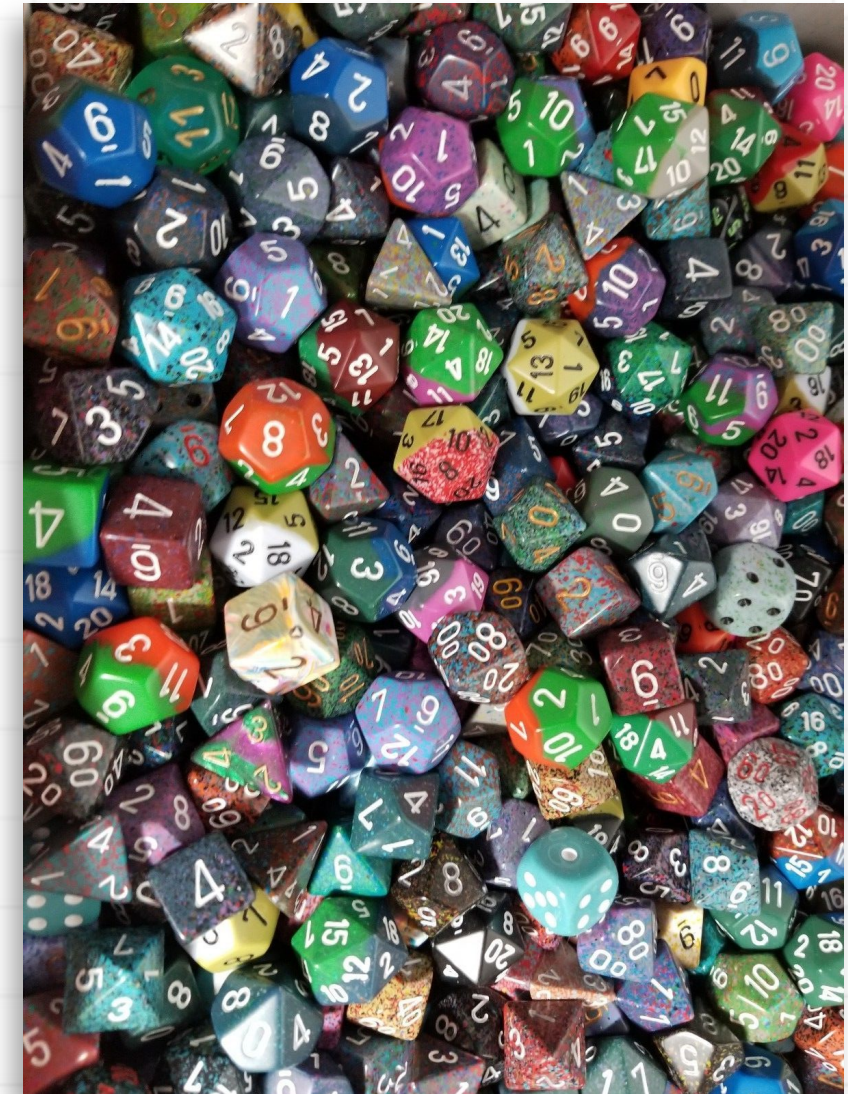
- ♣ No consistency across game
- ♣ Isolated
- ♣ 1 in 6

- ♣ Ubiquitous
- ♣ Creates a pervasive environment to adapt to
- ♣ 1 in 16+





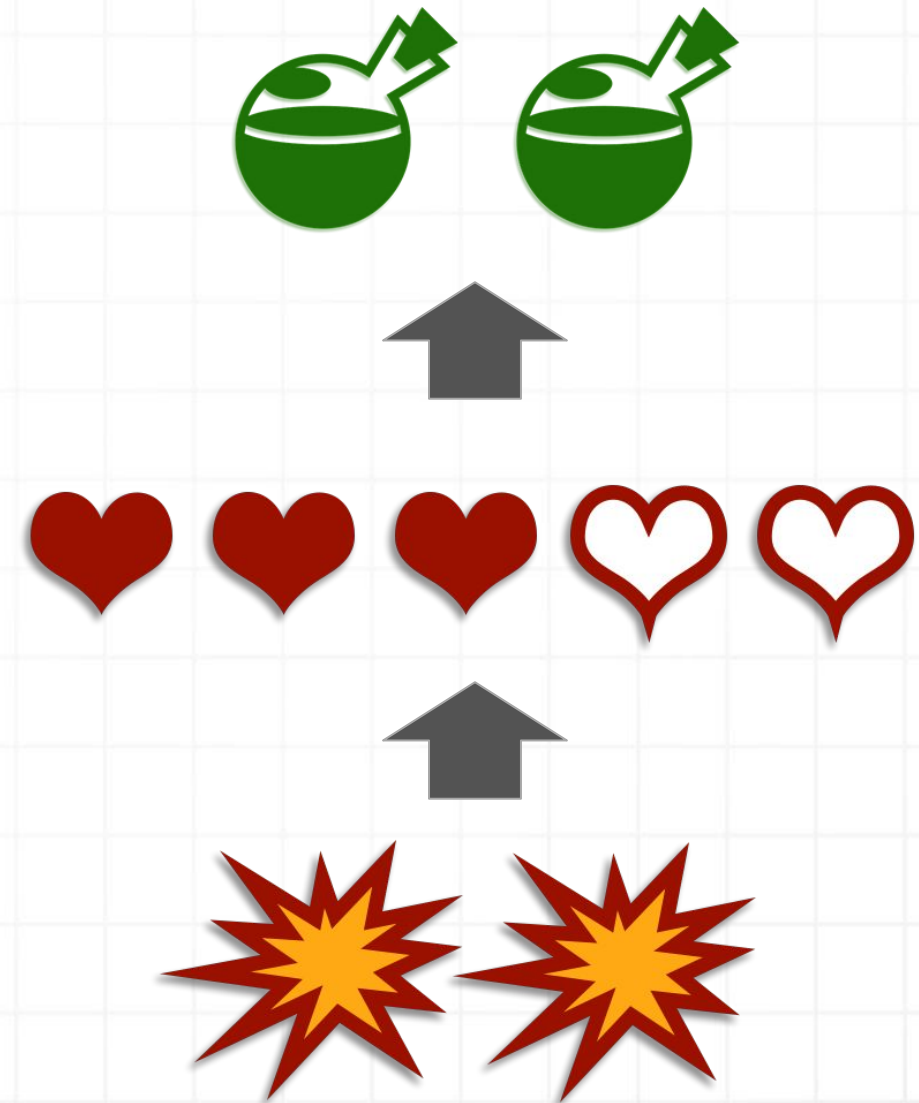
# Interventions in the flow of combat



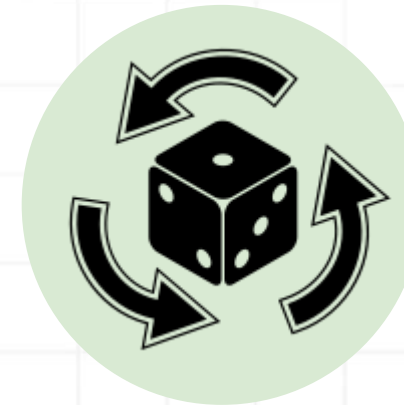
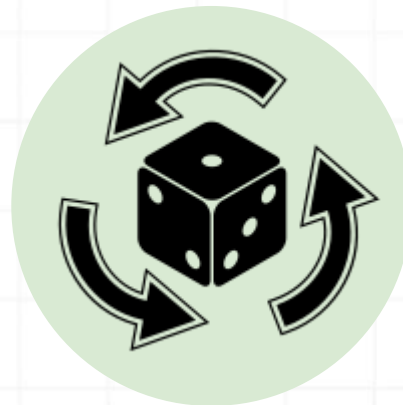
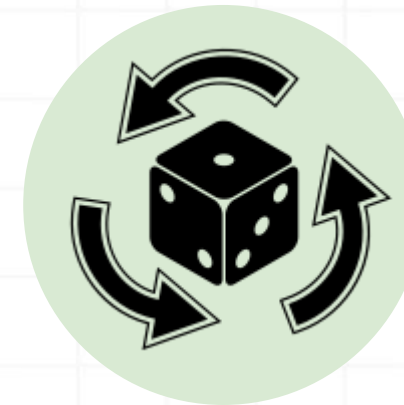
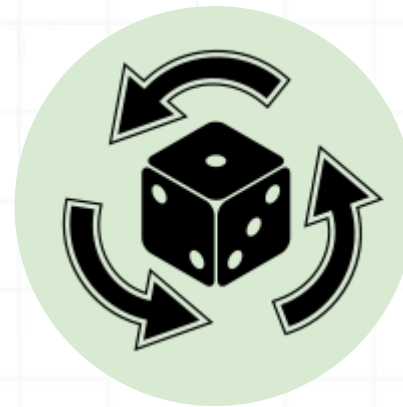
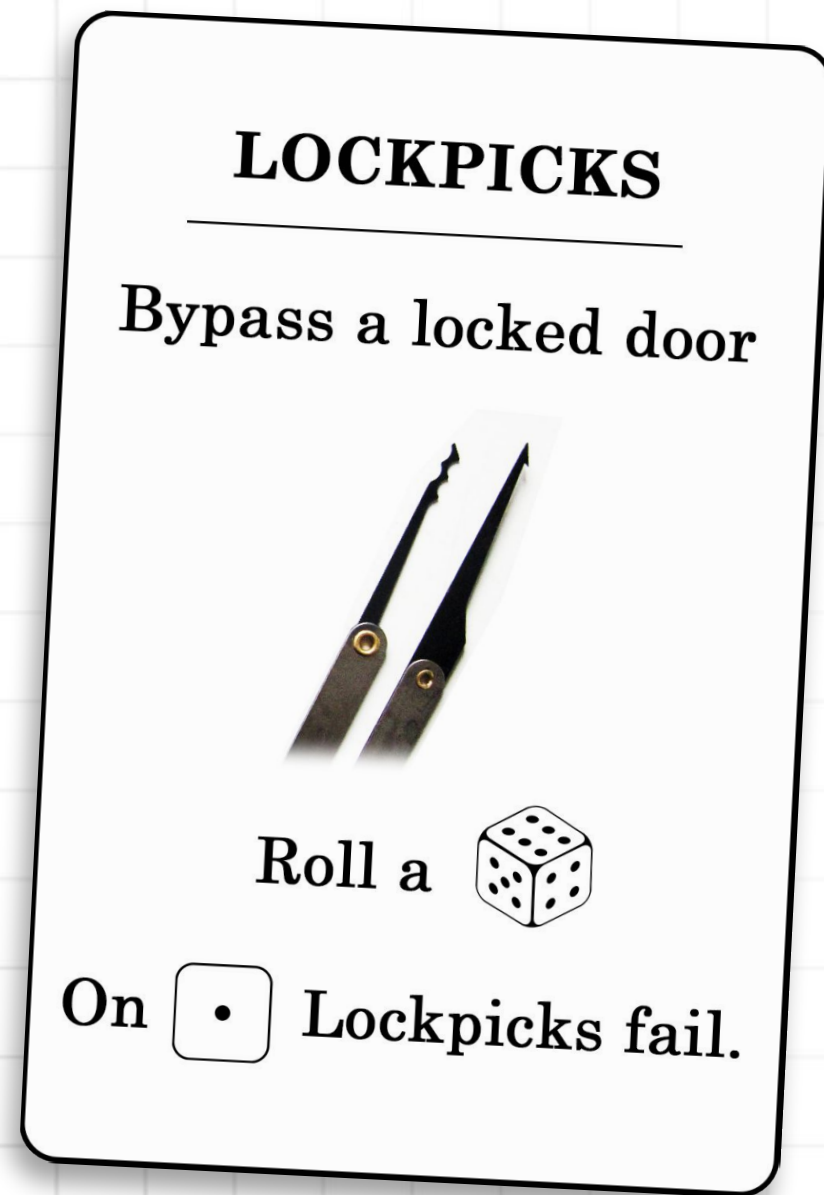


# Hierarchy of Failure

- ♣ Potions are an intervention
- ♣ They are also an early warning system
- ♣ Staggered failure like this is a tool for the player to monitor and manage randomness



# Adding Hierarchical Failure



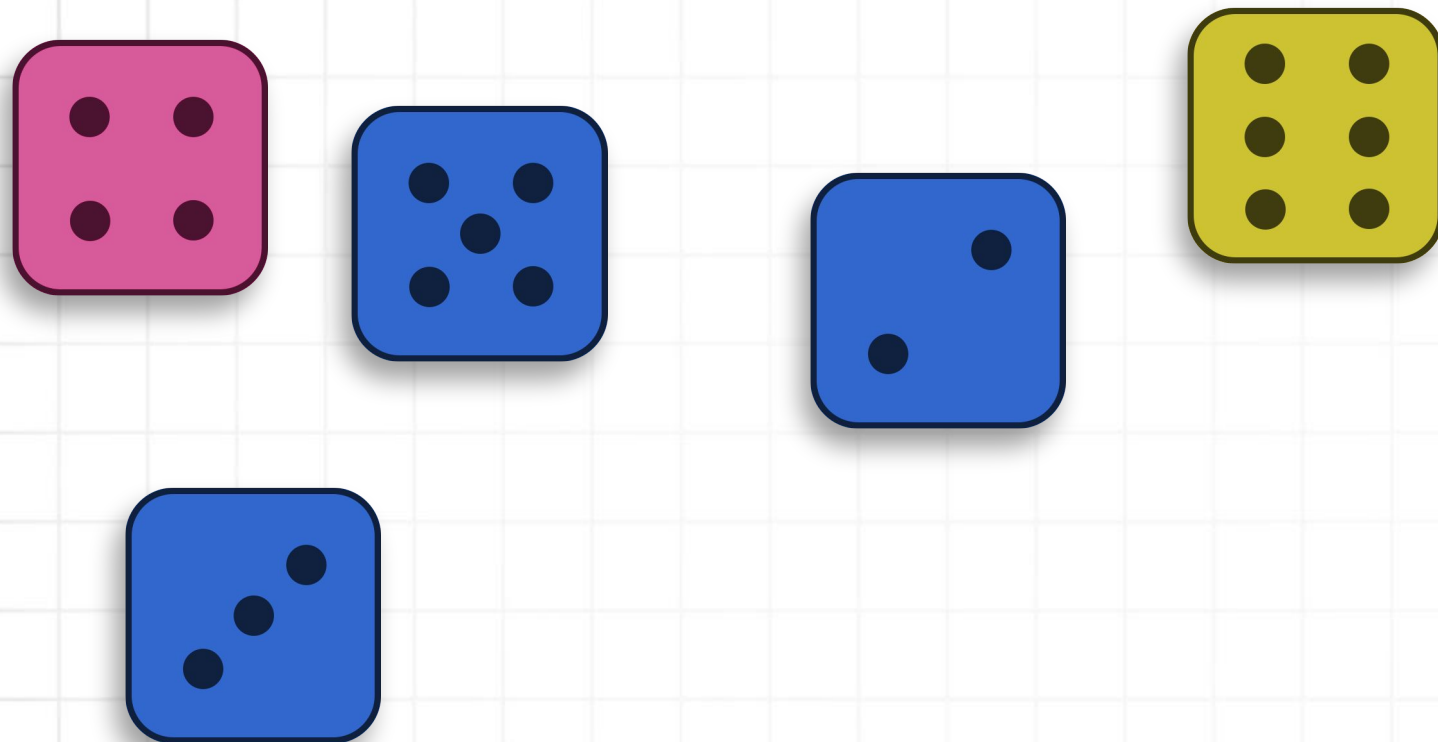


# Tools To Manage Randomness

- ♣ Aggregate Randomness
- ♣ Player Choice
- ♣ Hierarchies of success/failure to monitor flow of randomness
- ♣ ...

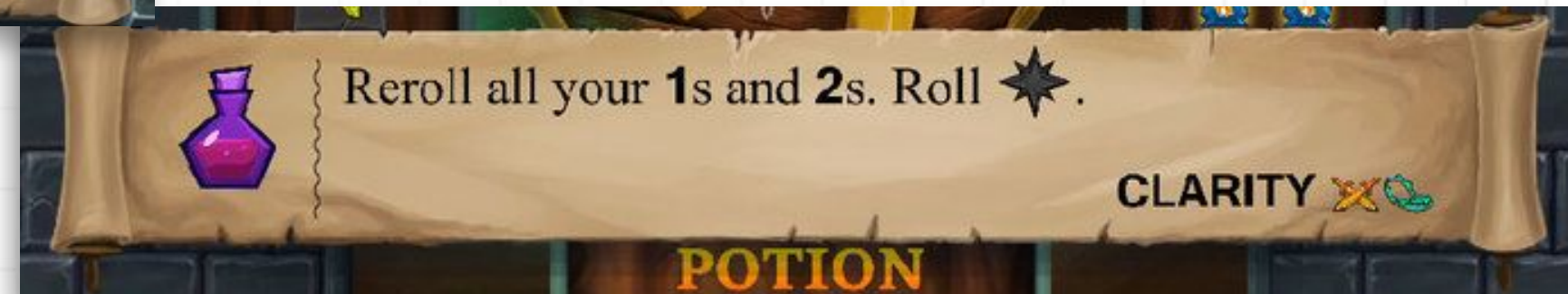
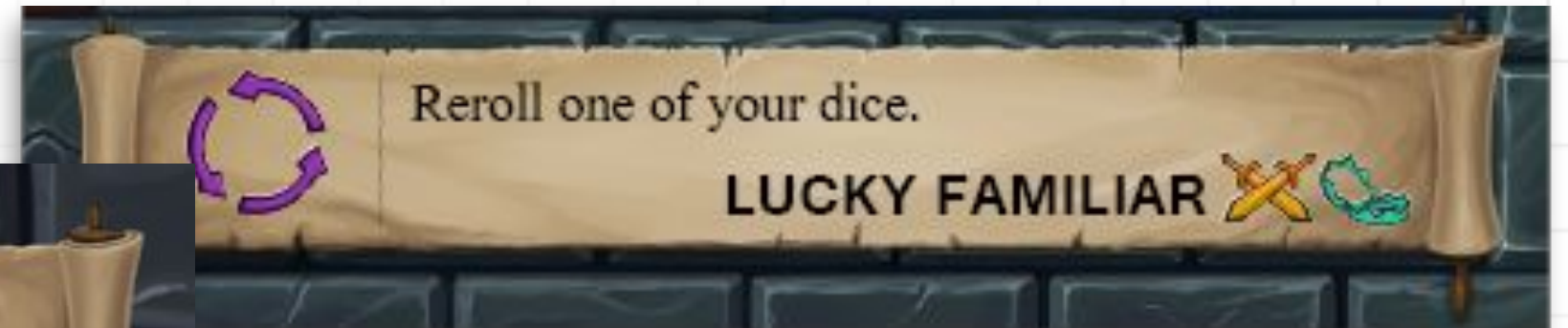
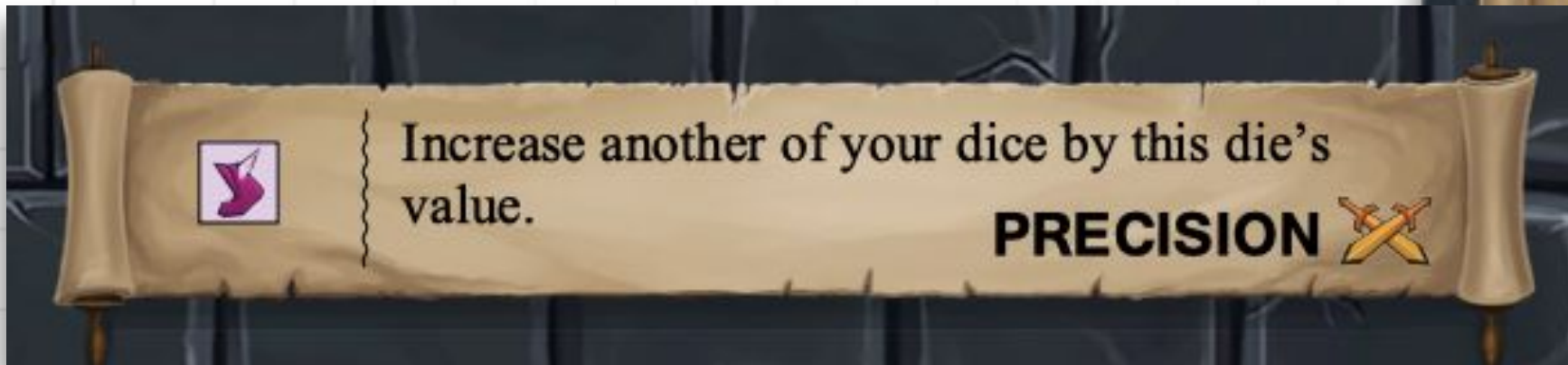


# *One Deck Dungeon*



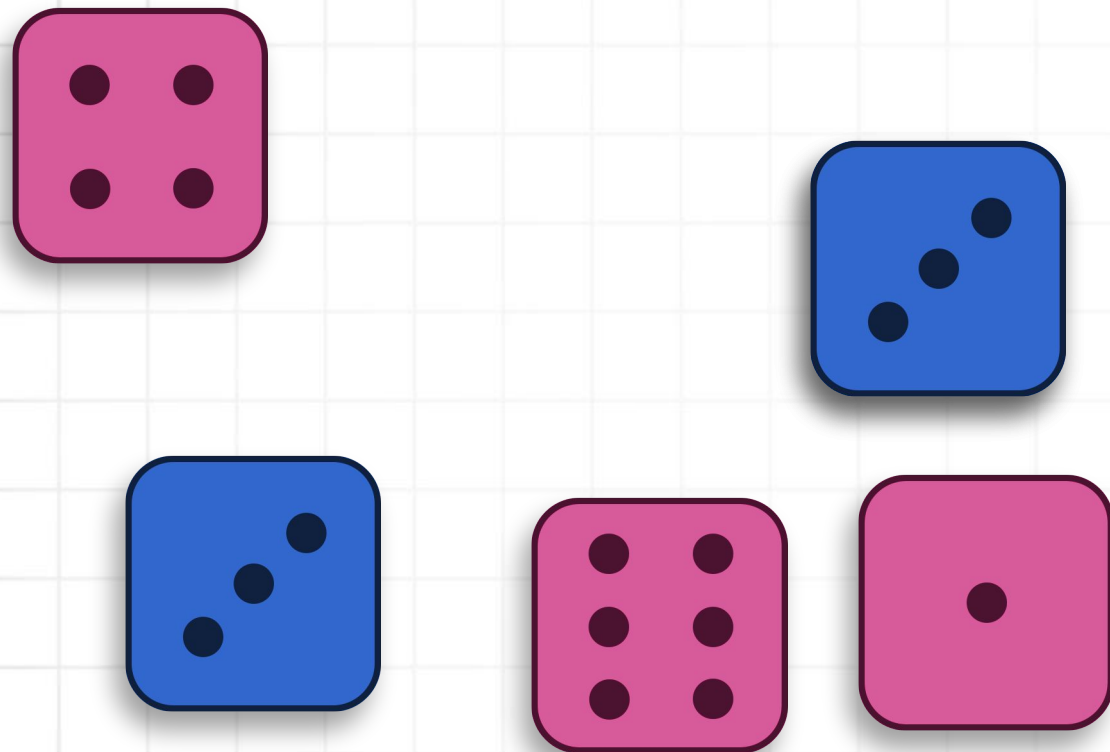


# Tools to Control Randomness





# One Deck Dungeon

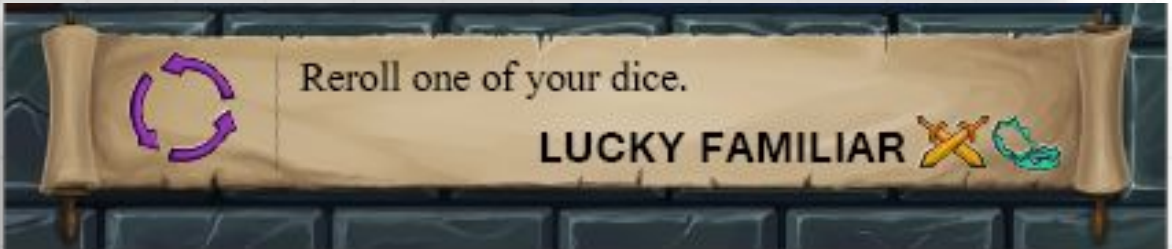


Increase another of your dice by this die's value.

**PRECISION** ⚔️

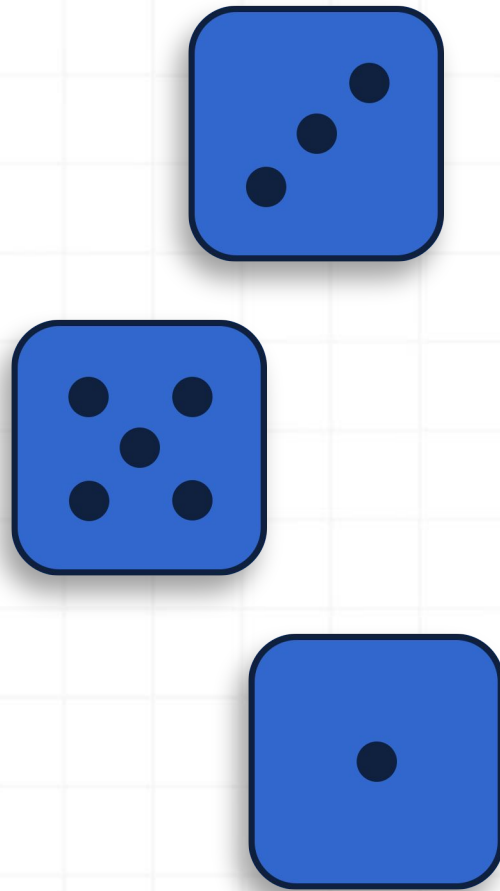
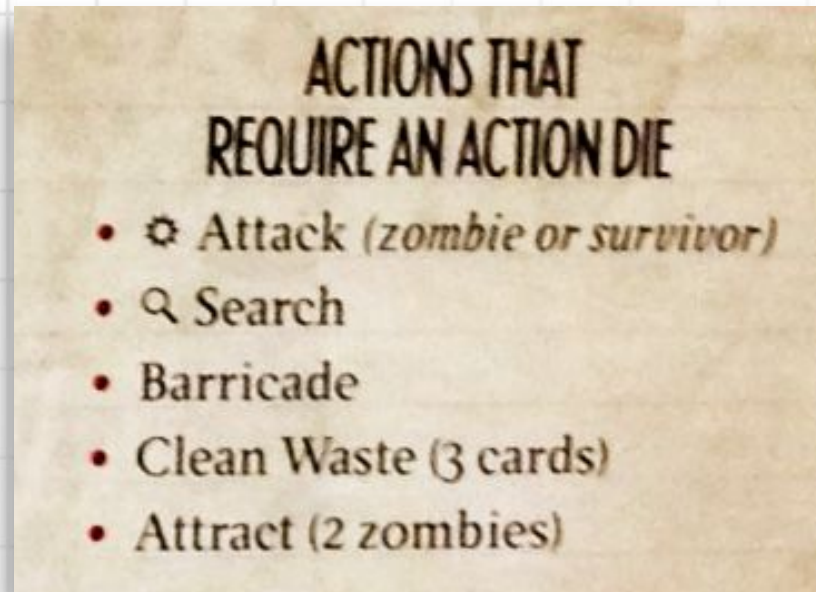


# One Deck Dungeon



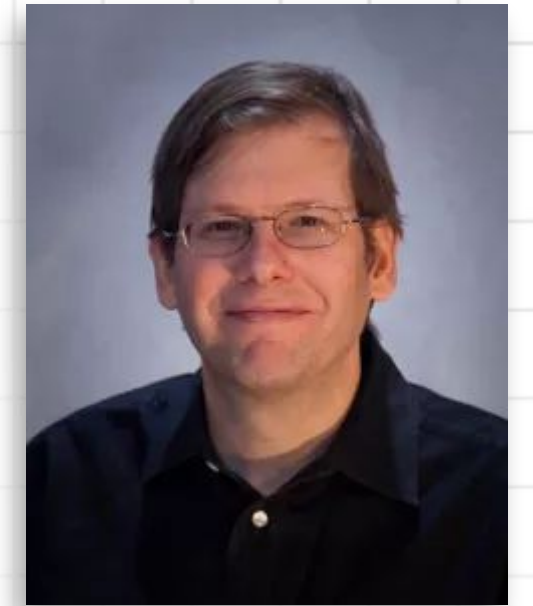
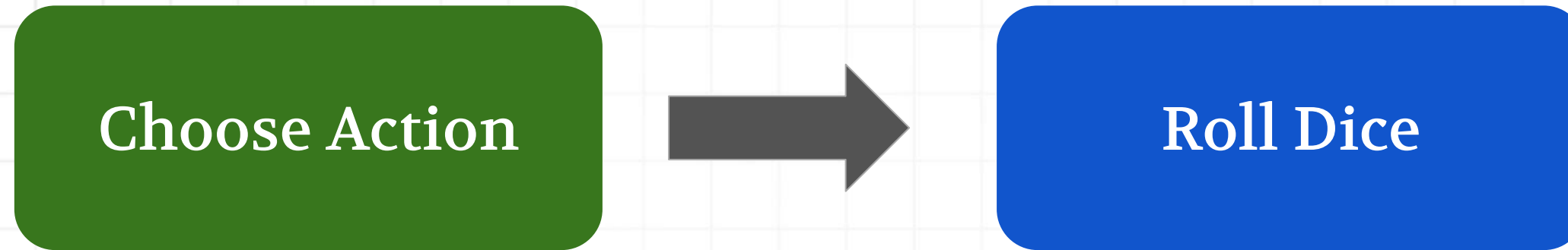


# Dead of Winter



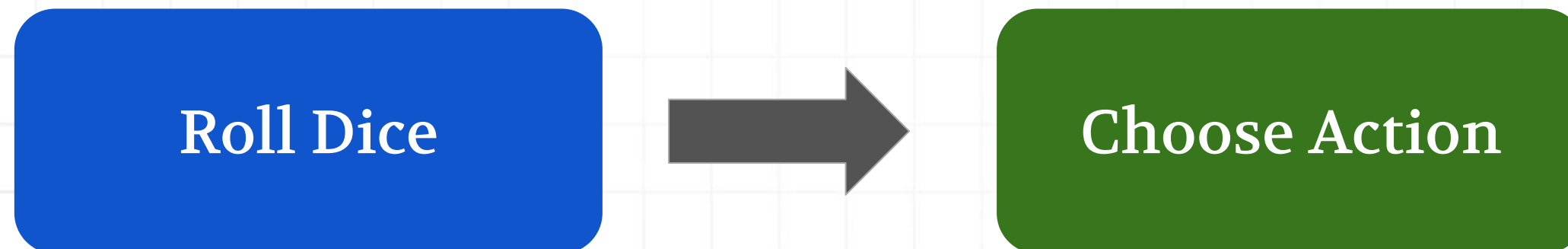


# Output Randomness



Geoff  
Engelstein  
of *Ludology*,  
*GameTek*,  
*McDie*, etc.

# Input Randomness



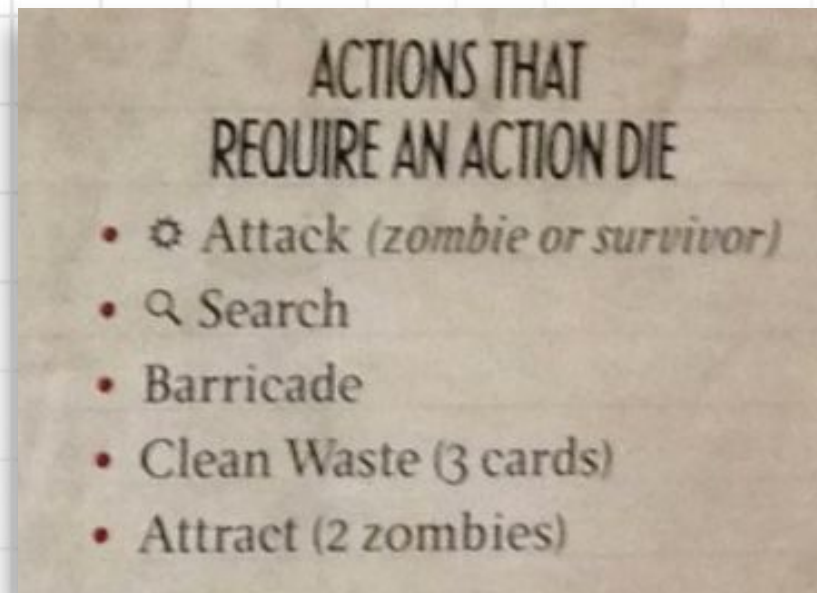


# Rogue-likes as Input Randomness

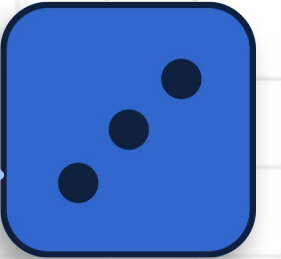




# Dead of Winter

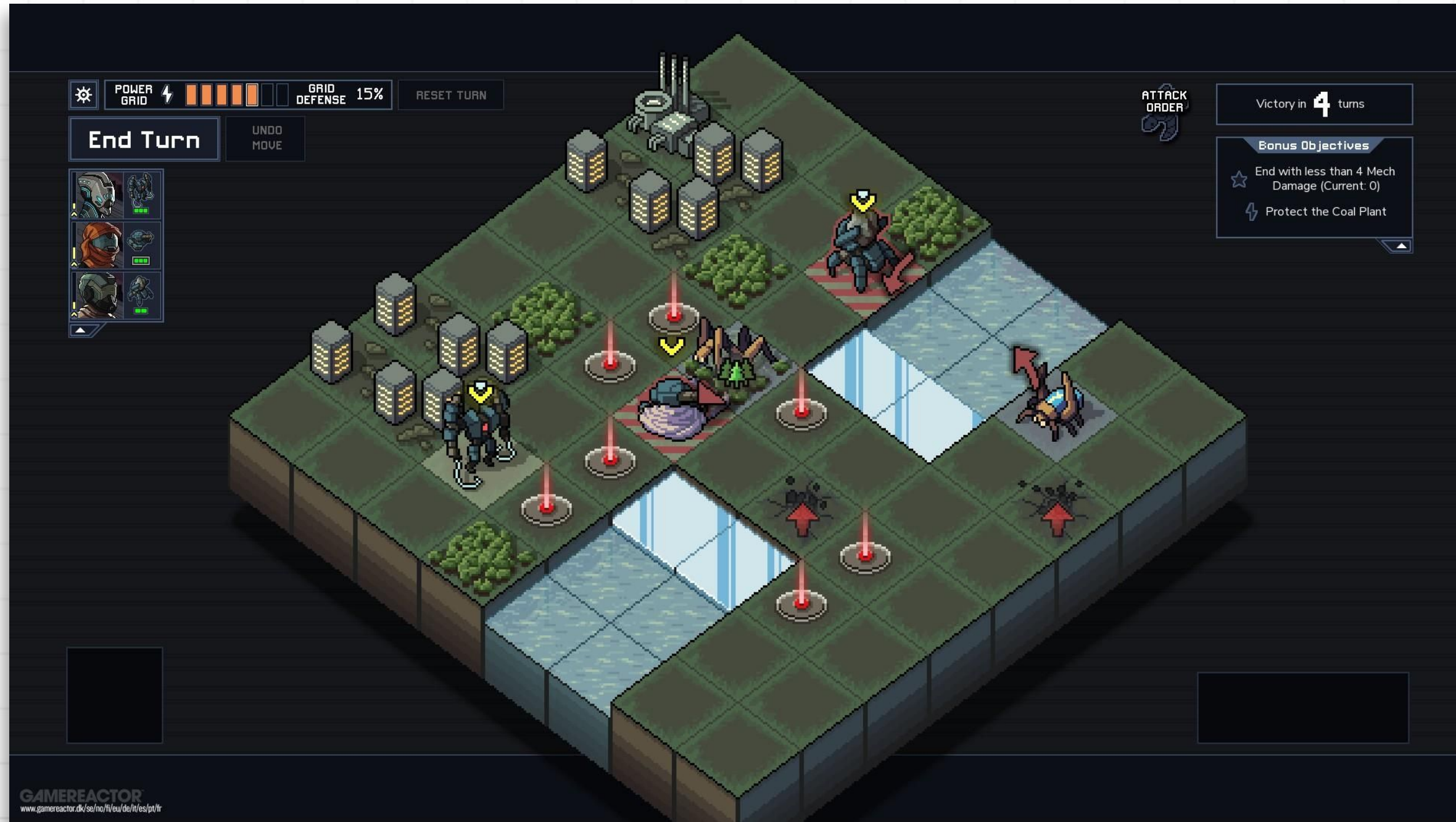


Actions  
left:  
2





# *Into The Breach* as Input Randomness



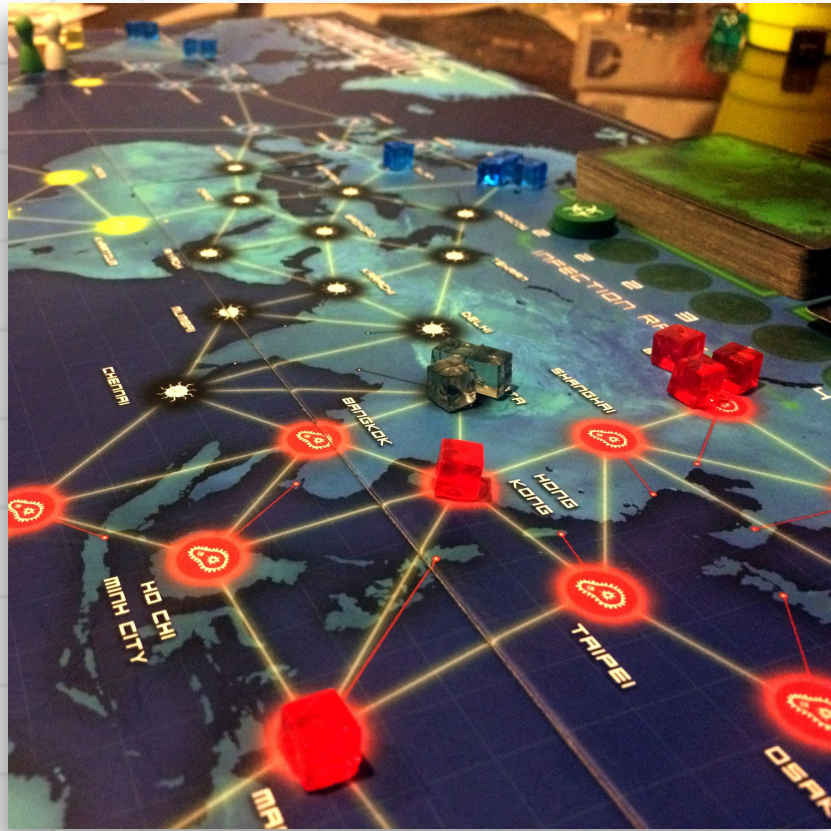


# Chess has no randomness





# Randomness creates a “planning horizon”



**Little randomness:  
Plan future moves**

**Much randomness:  
Plan less far out**



# Uses for Randomness

- ♣ Drama (*celebration, frustration*)
- ♣ Tilts the playing field, dilutes player skill contribution
- ♣ **Creates a planning horizon**
- ♣ **Saves players from too much planning**
- ♣ **Planning → Improvisation**
- ♣ **Variety**
- ♣ ...





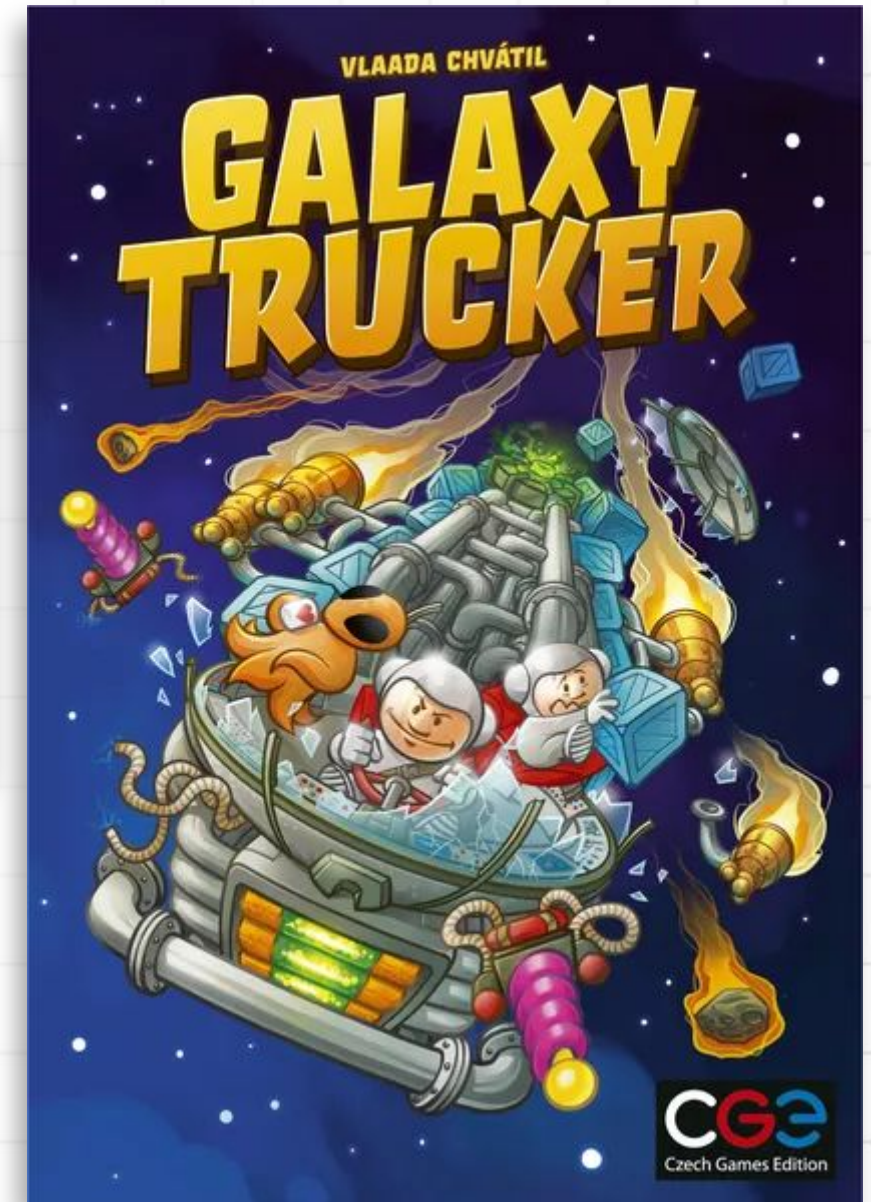
# Tools To Manage Randomness

- ♣ Aggregate Randomness
- ♣ Input vs Output Randomness
- ♣ Player Choice
- ♣ Hierarchies of success/failure to monitor flow of randomness
- ♣ **Manipulating die rolls: re-roll, add, subtract, transform, etc.**
- ♣ ...



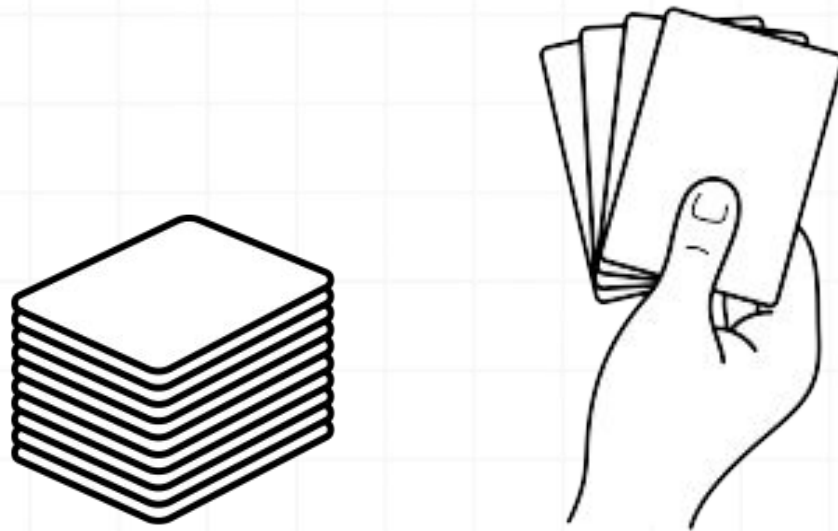


# Chaos and Surprise



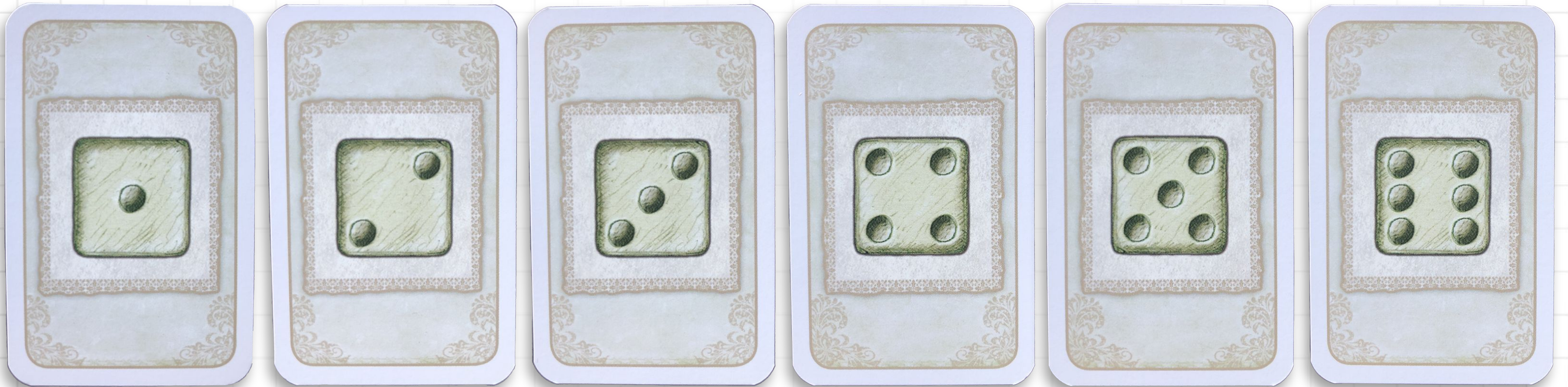


# *Part 2: Cards*





# Deck of “Dice Cards”





# Deck of “Dice Cards”





# Deck of “Dice Cards”



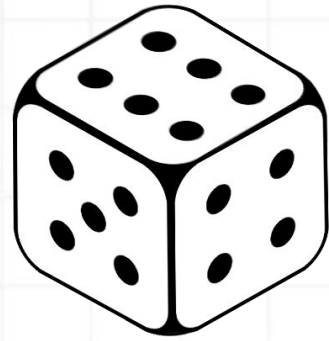


# Deck of “Dice Cards”





# Dice vs Cards

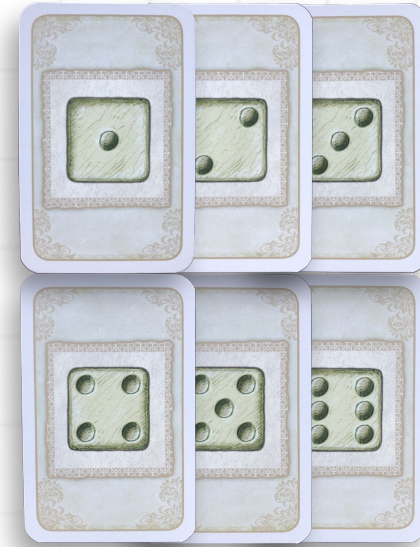


Pure  
Randomness

No  
Memory

Random  
Distribution

Sampling with  
Replacement



Controlled  
Randomness

Has  
Memory

Even  
Distribution

Sampling  
without  
Replacement

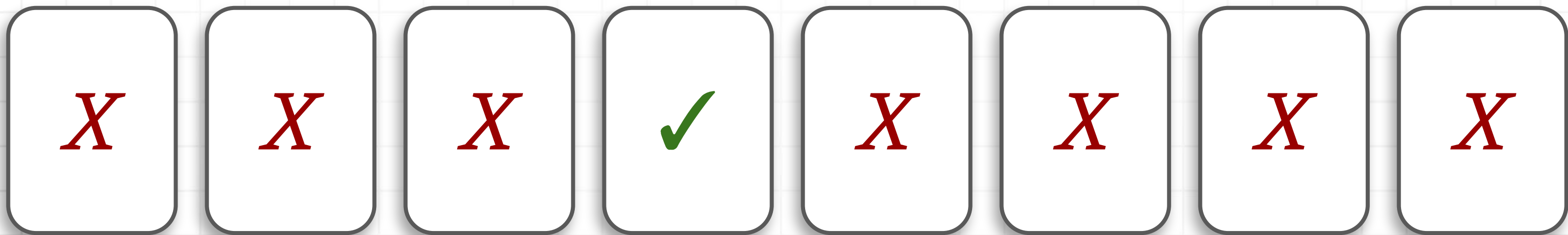


# Takeaway Use Cards Instead of Dice (or consider doing so)





# Use Cards Instead of Dice

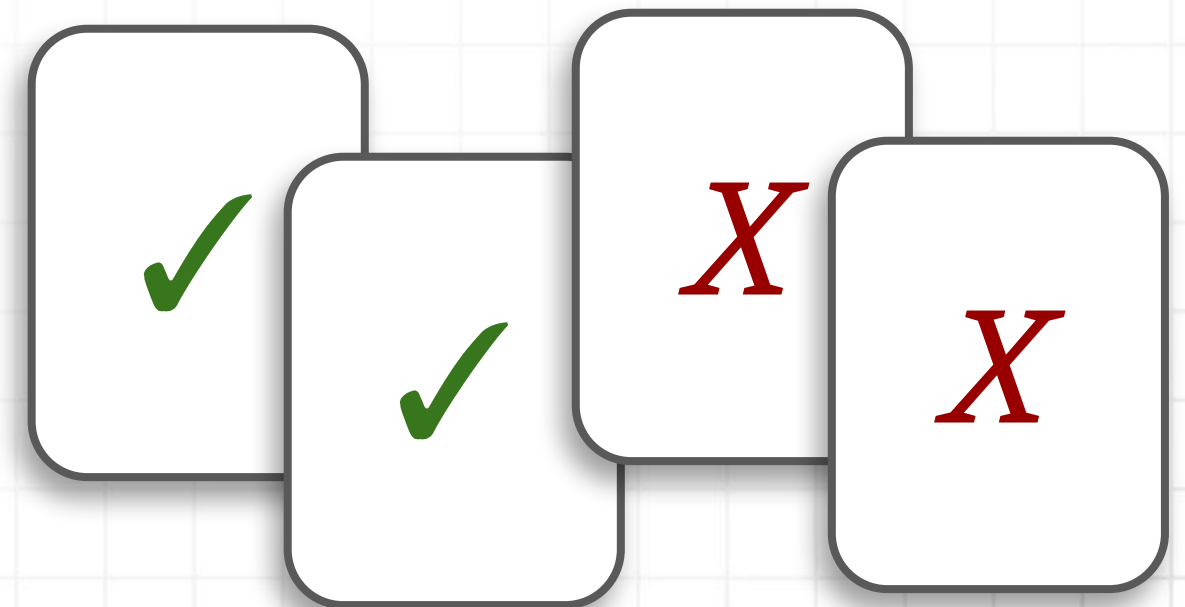




# Use Cards Instead of Dice



**VAMPIRIC BITE** - Any Town Elder killed by the Vampire is turned into a Vampire Elder (Evil Elder) on the D6 roll of 4+, discarding any Secrets they have and joining the Vampire as an Evil Elder.





# Use Cards Instead of Dice





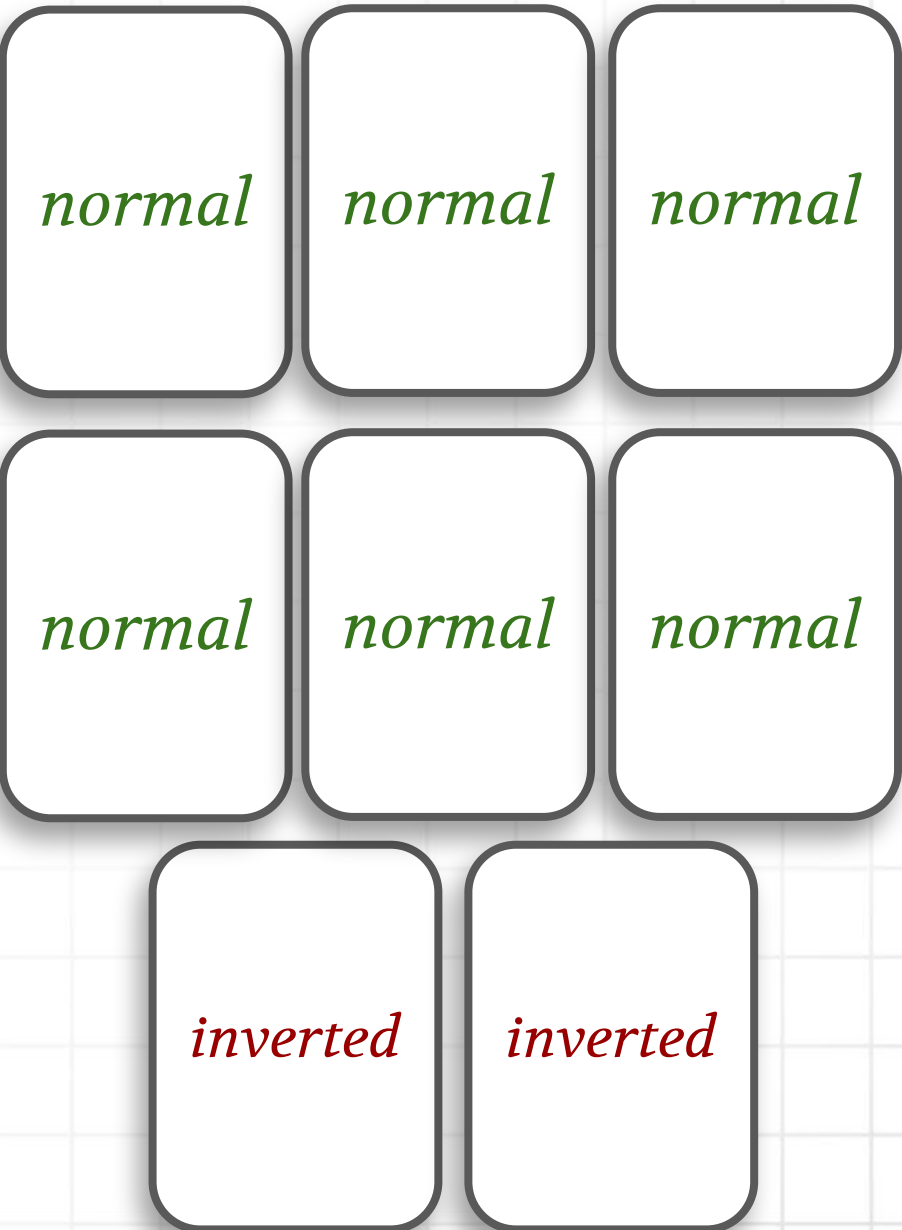
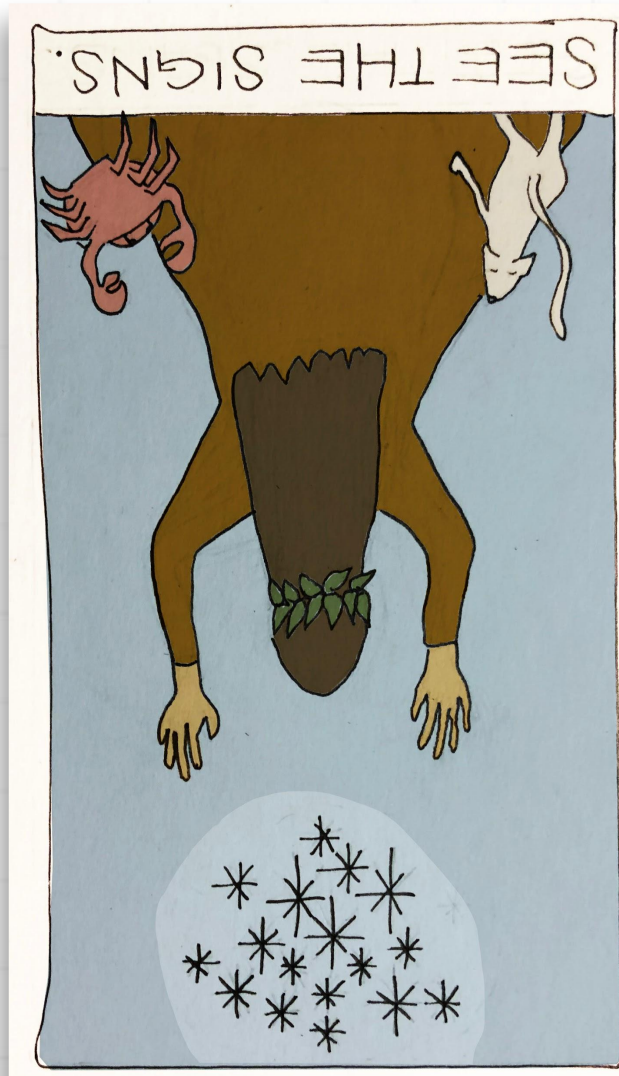
# Digital Games Can Use...

- ♣ ...many decks.
- ♣ ...very large decks.
- ♣ ...complex nested decks that refer to each other.





# Use Cards Instead of Dice

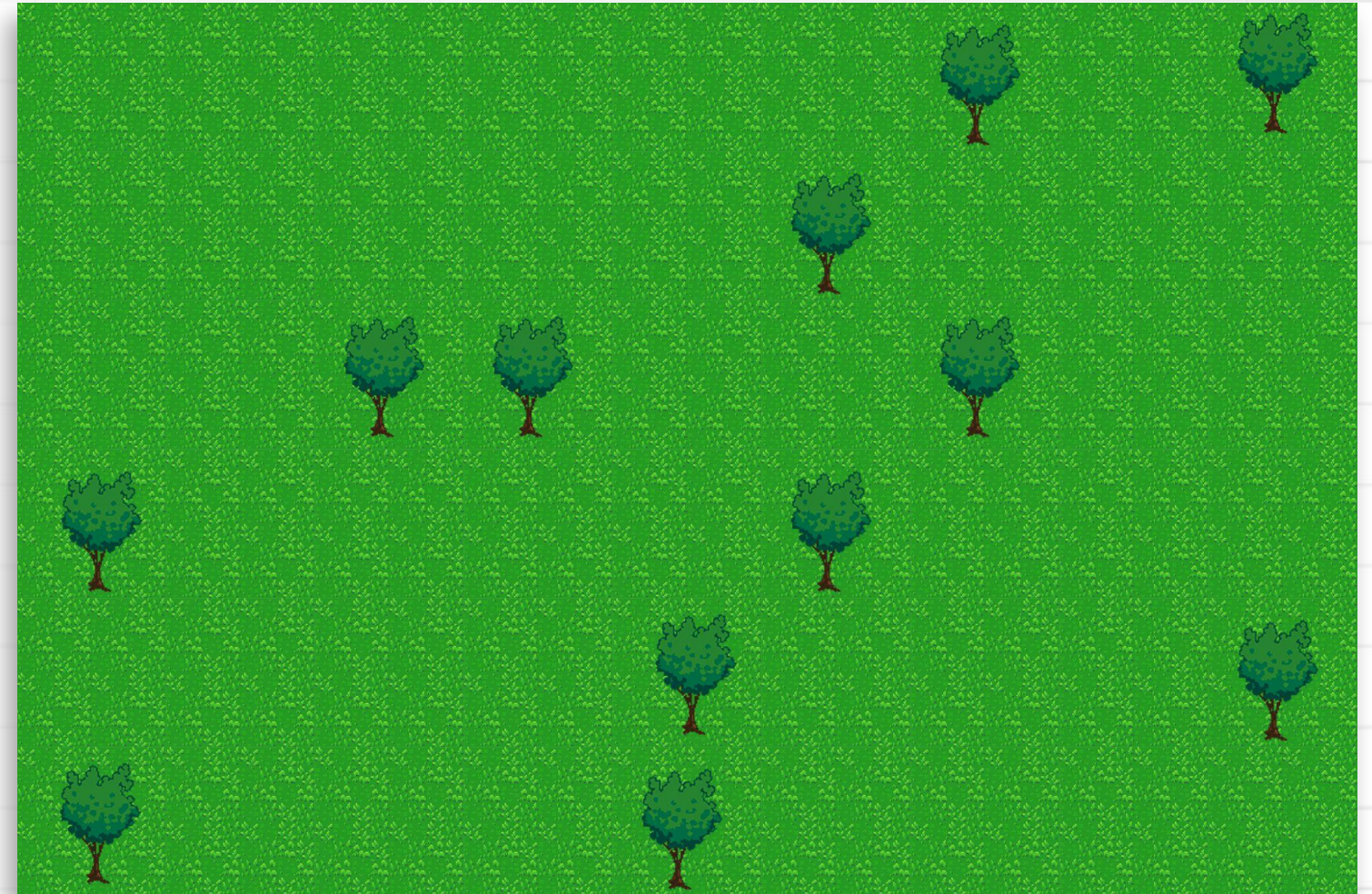




# Procedural Generation



Even distribution  
(cards)

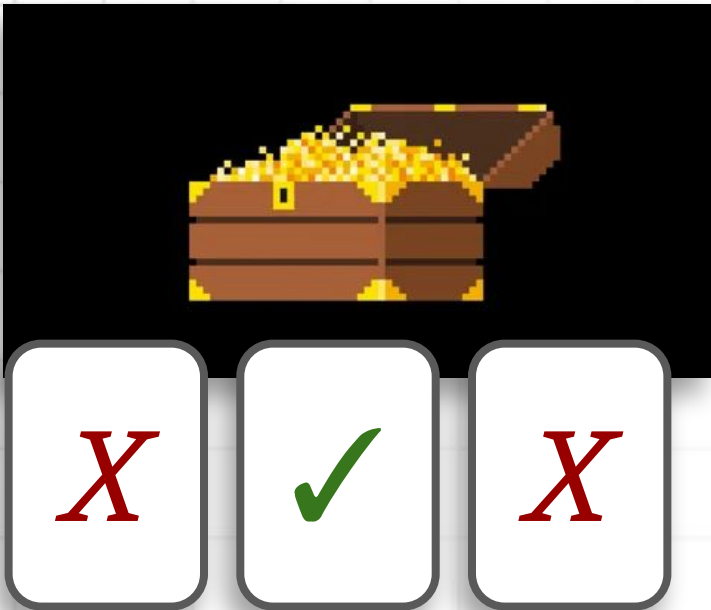


Random distribution  
(dice)



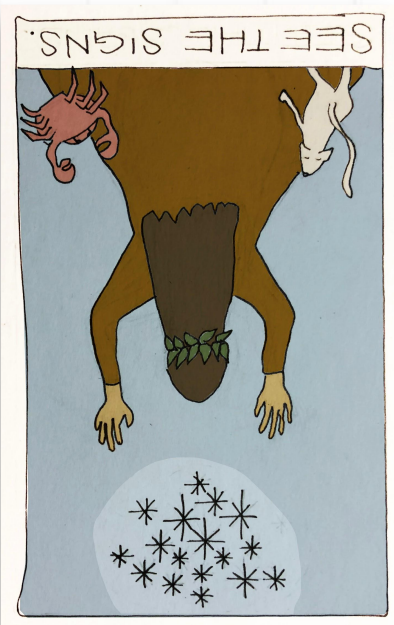


# Transparency to the Player



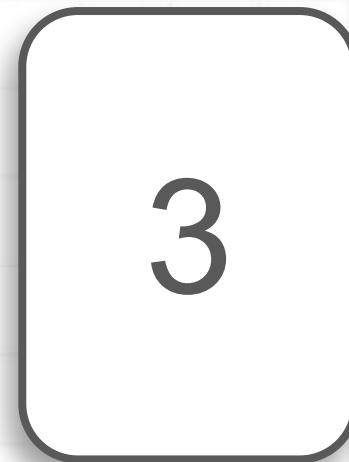
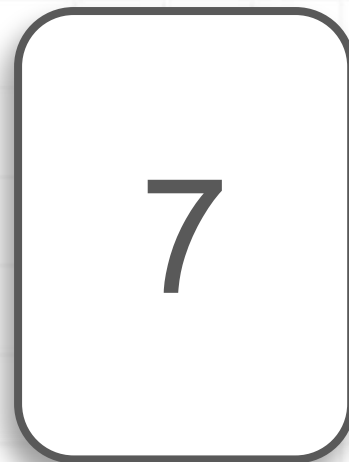
~~“50% chance”~~

“happens 50% of the time”





# Card Probability Math



~~10~~  
cards  
remaining

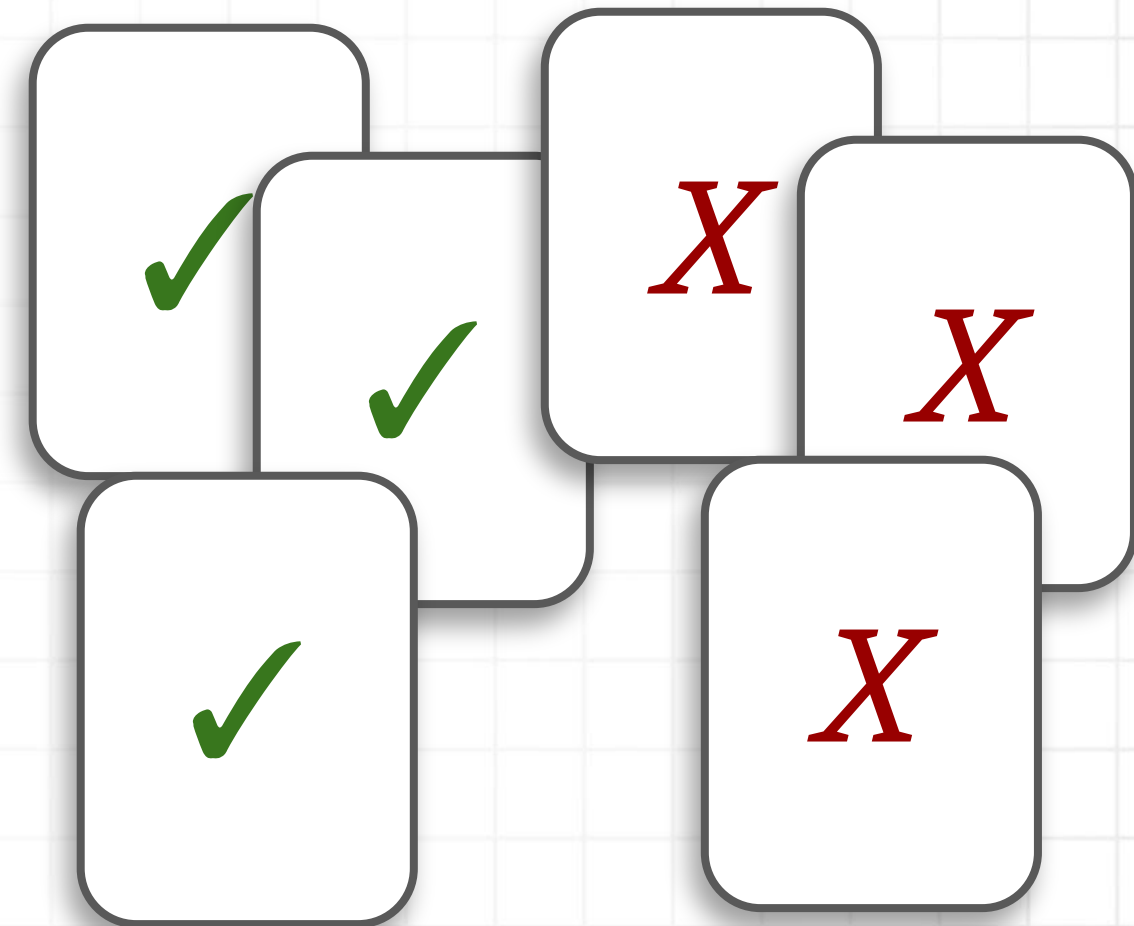
$$\frac{1}{\cancel{10}} = 12\cancel{1}\cancel{5}\%$$





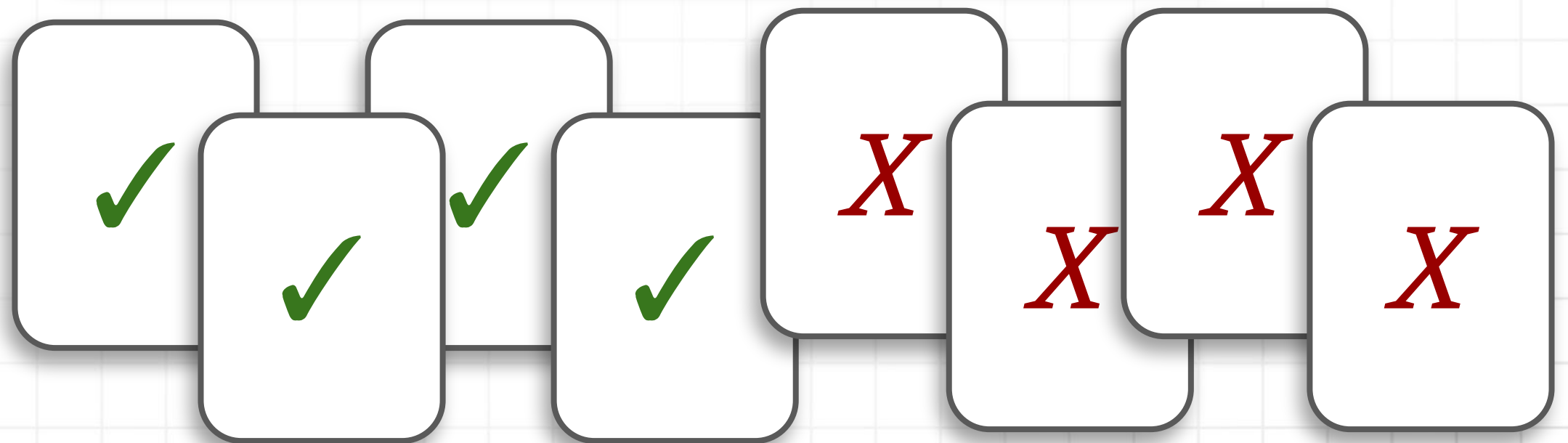
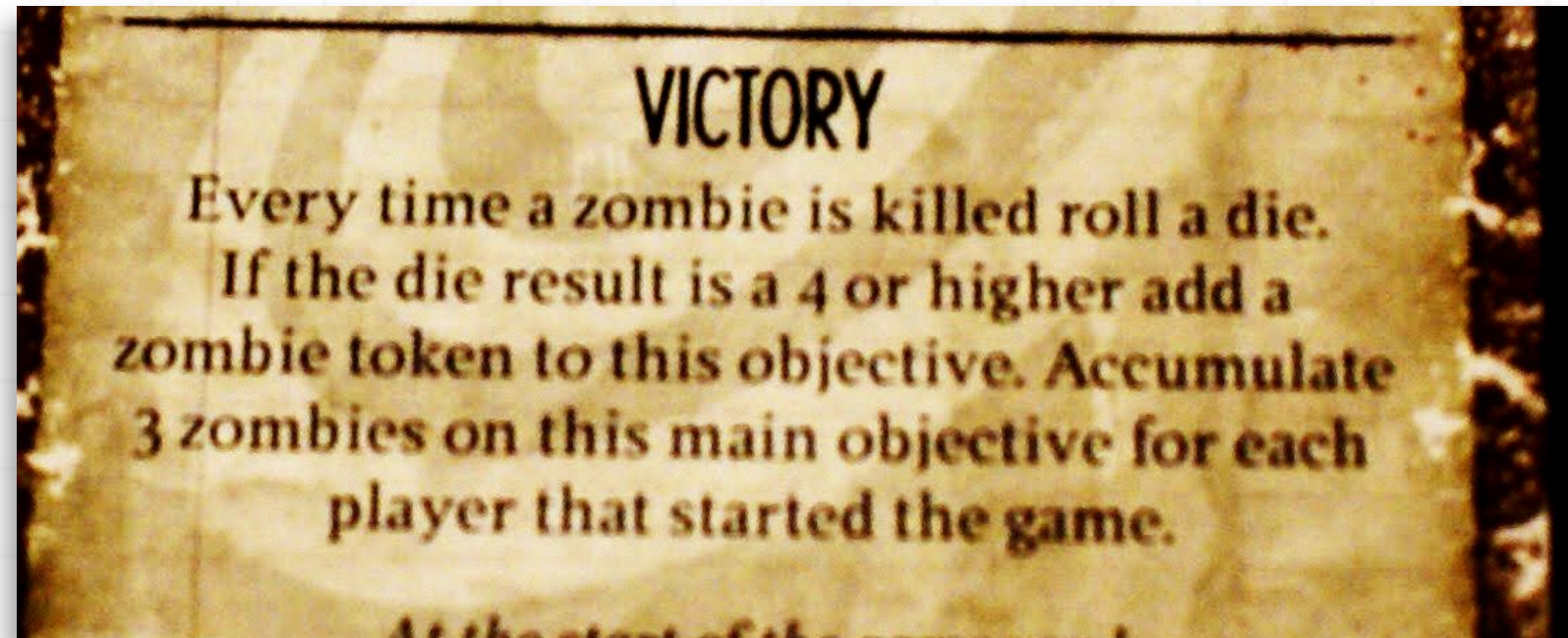
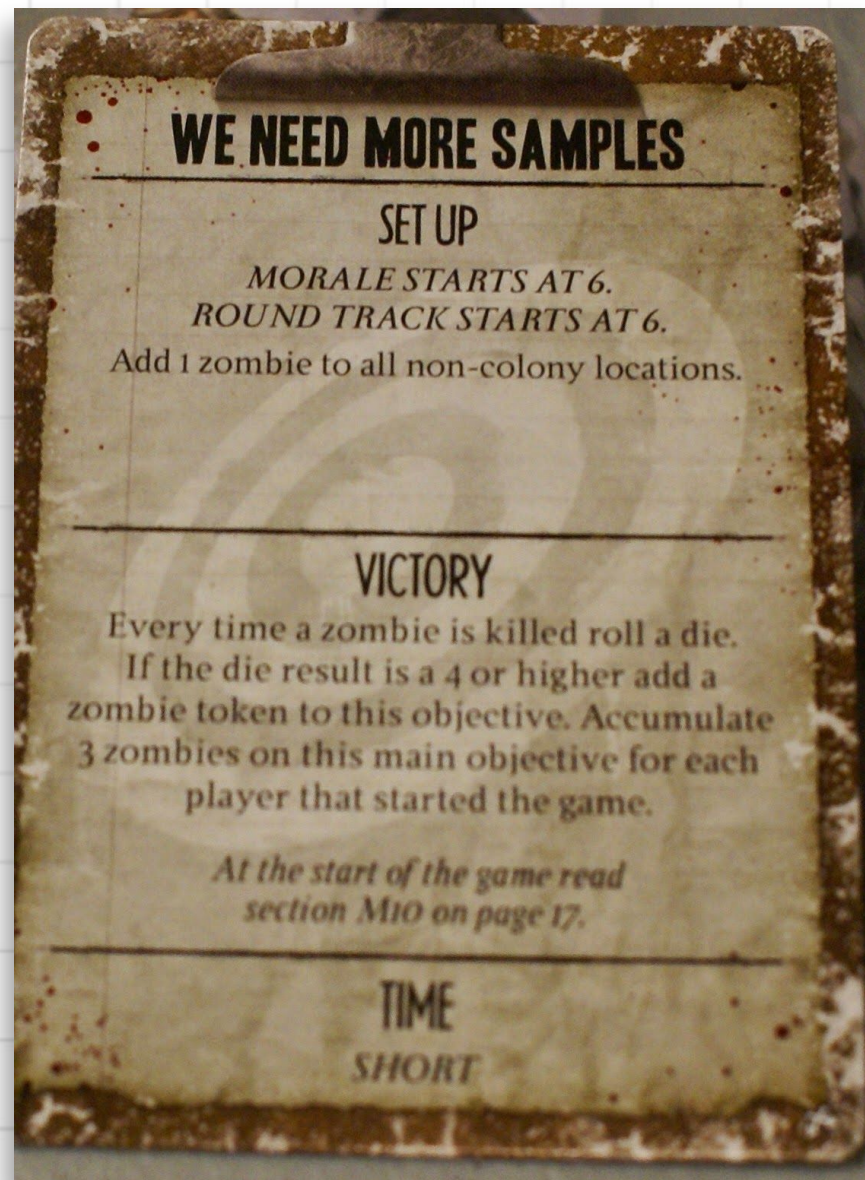
# Deck Size

3 events





# Deck Size





# Card Probability Math



looking for 1  
specific card  
in a deck of  
10

| Draw |                   | Odds | Cumulative |
|------|-------------------|------|------------|
| 1st  | $1/10$            | 10%  | 10%        |
| 2nd  | $90\% \times 1/9$ | 10%  | 20%        |
| 3rd  | $80\% \times 1/8$ | 10%  | 30%        |
| 4th  | $70\% \times 1/7$ | 10%  | 40%        |
| 5th  | $60\% \times 1/6$ | 10%  | 50%        |





# Card Probability Math



looking for  
either of 2  
cards in a  
deck of 10

| Draw |           | Odds | Cumulative |
|------|-----------|------|------------|
| 1st  | 2/10      | 20%  | 20%        |
| 2nd  | 80% x 2/9 | 18%  | 38%        |
| 3rd  | 62% x 2/8 | 16%  | 53%        |
| ...  | ...       | ...  | ...        |
|      |           |      |            |





# Player Draw Pile in *Arkham Horror LCG*



Odds that  
specific  
cards are in  
the bottom  
10 cards of a  
deck of 30  
cards



1 card = 33%

2 cards = 10%  
(if you need either card)

2 cards = 56%  
(if you need both cards)





# Player Draw Pile in *Arkham Horror LCG*



Odds that  
specific  
cards are in  
the bottom  
10 cards of a  
deck of 30  
cards



= 33%

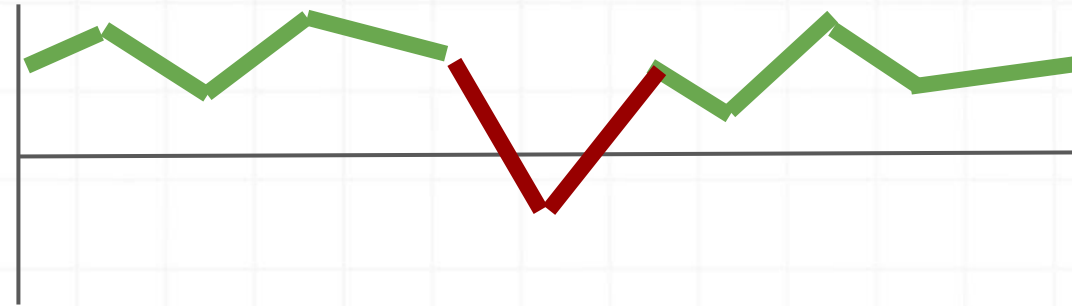
= 10%  
(either card)

= 56%  
(if you need both cards)



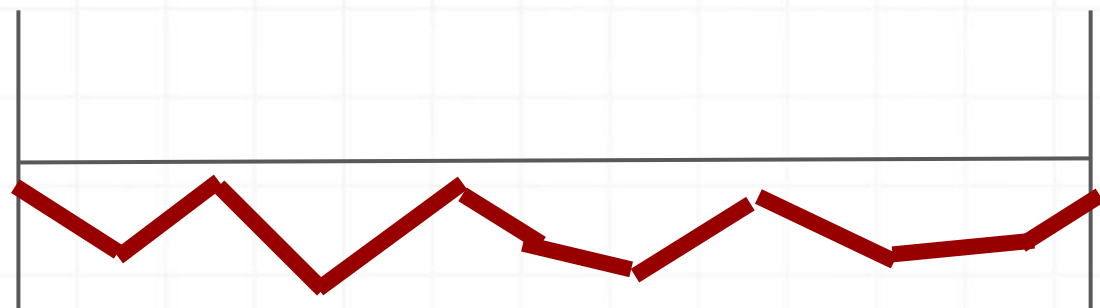


# Weakness cards in *Arkham Horror LCG*



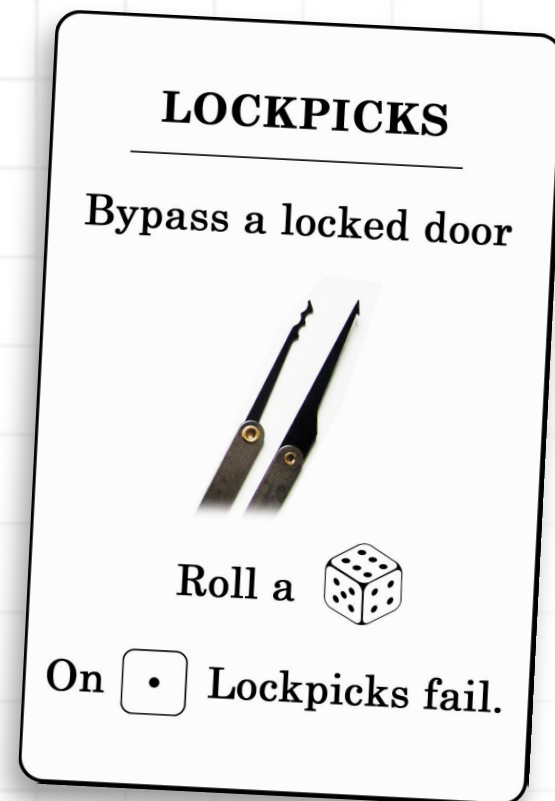


# Swinginess of Event Decks





# Applicability of Cards



only valuable if you're  
at a locked door



only valuable if you have  
many resources

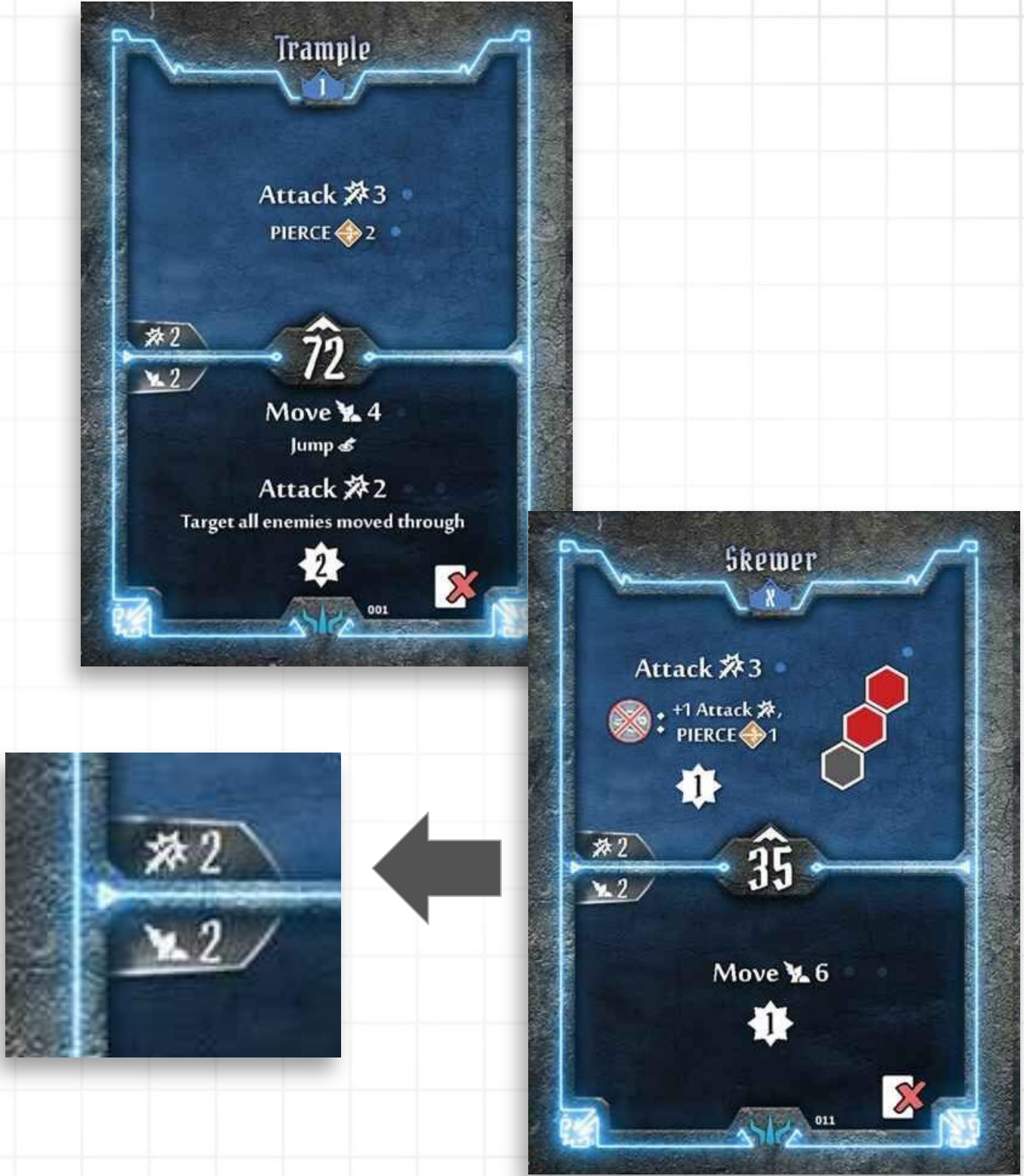


only valuable if you have  
a *firearm* item





# Multi-Use Cards





# Deckbuilders



*Honeymoon Whist*



*Slay The Spire*



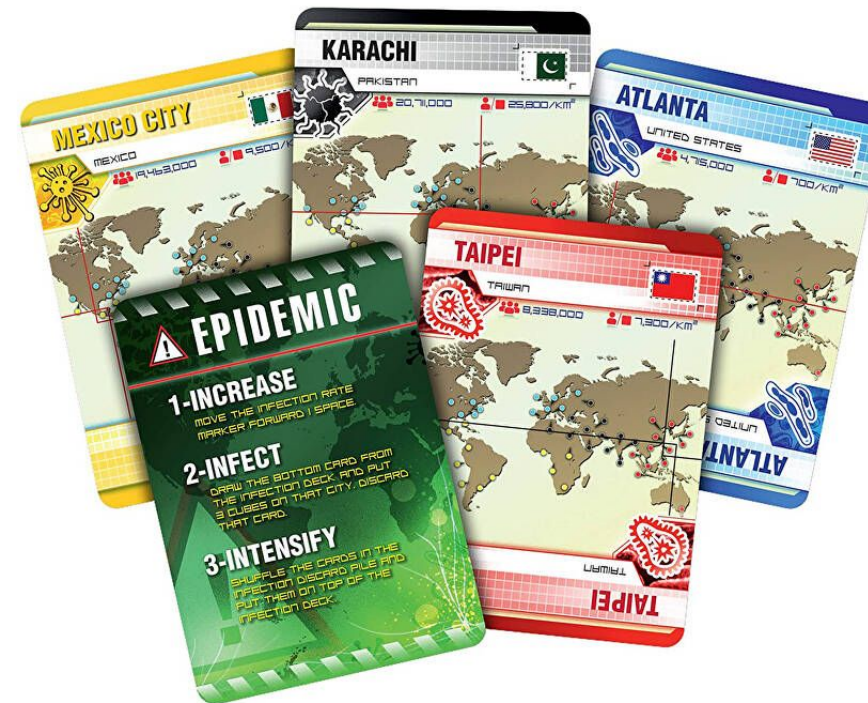
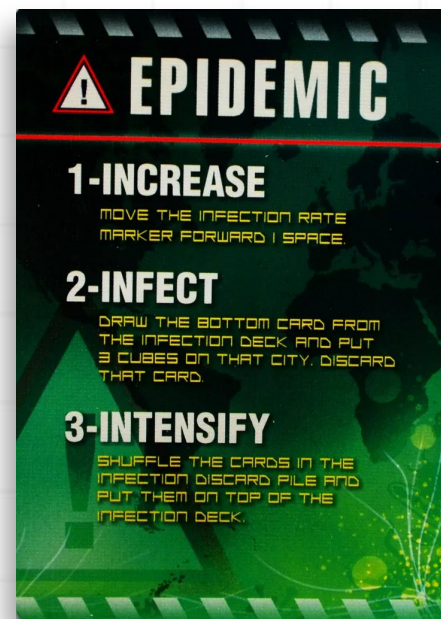
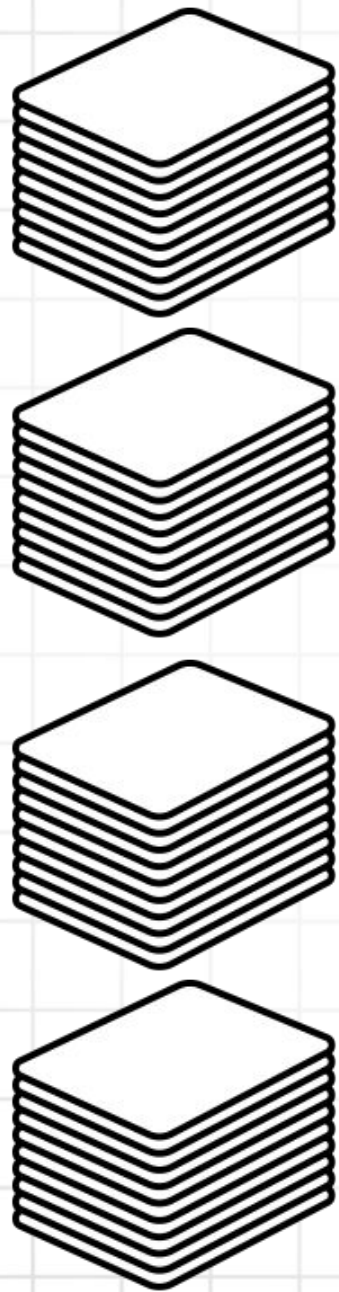
*Magic The Gathering*



*Dominion*



# Manipulating Decks

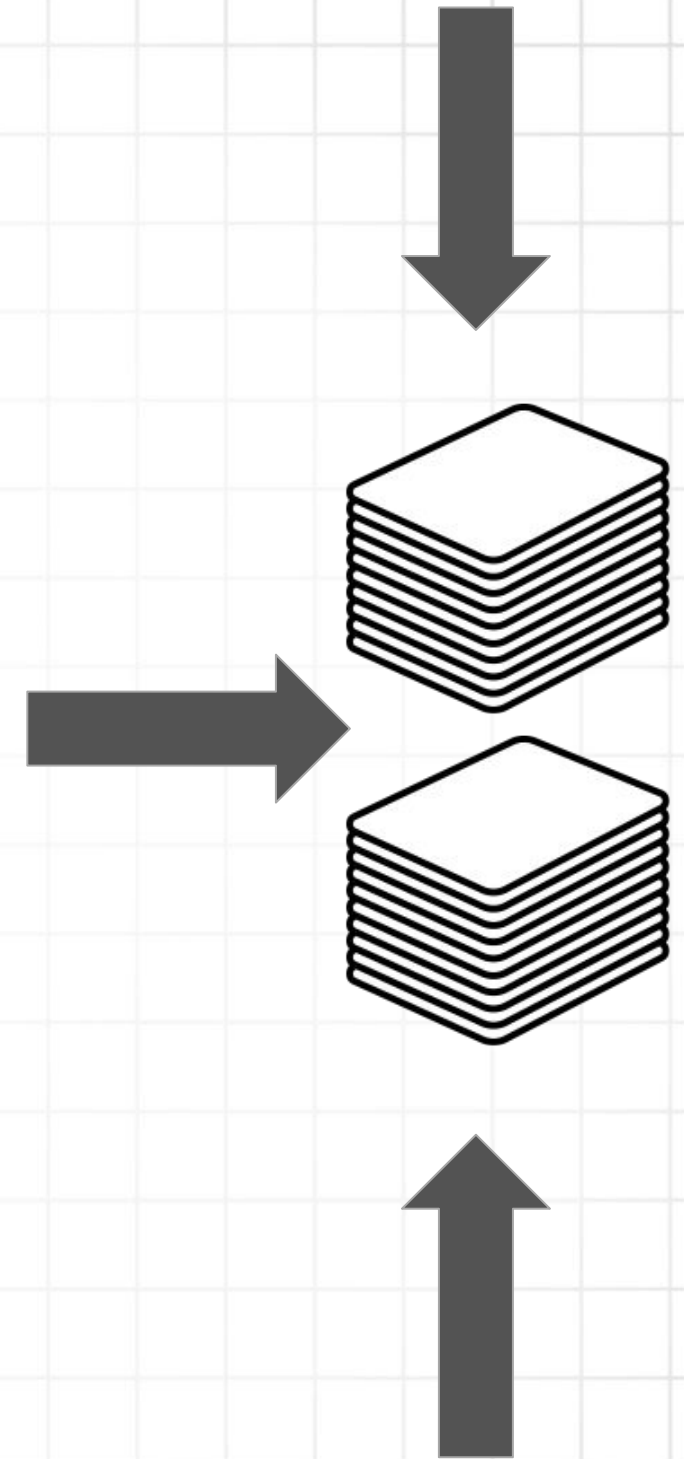


Matt Leacock  
of *Pandemic*,  
*Pandemic Legacy*, etc.



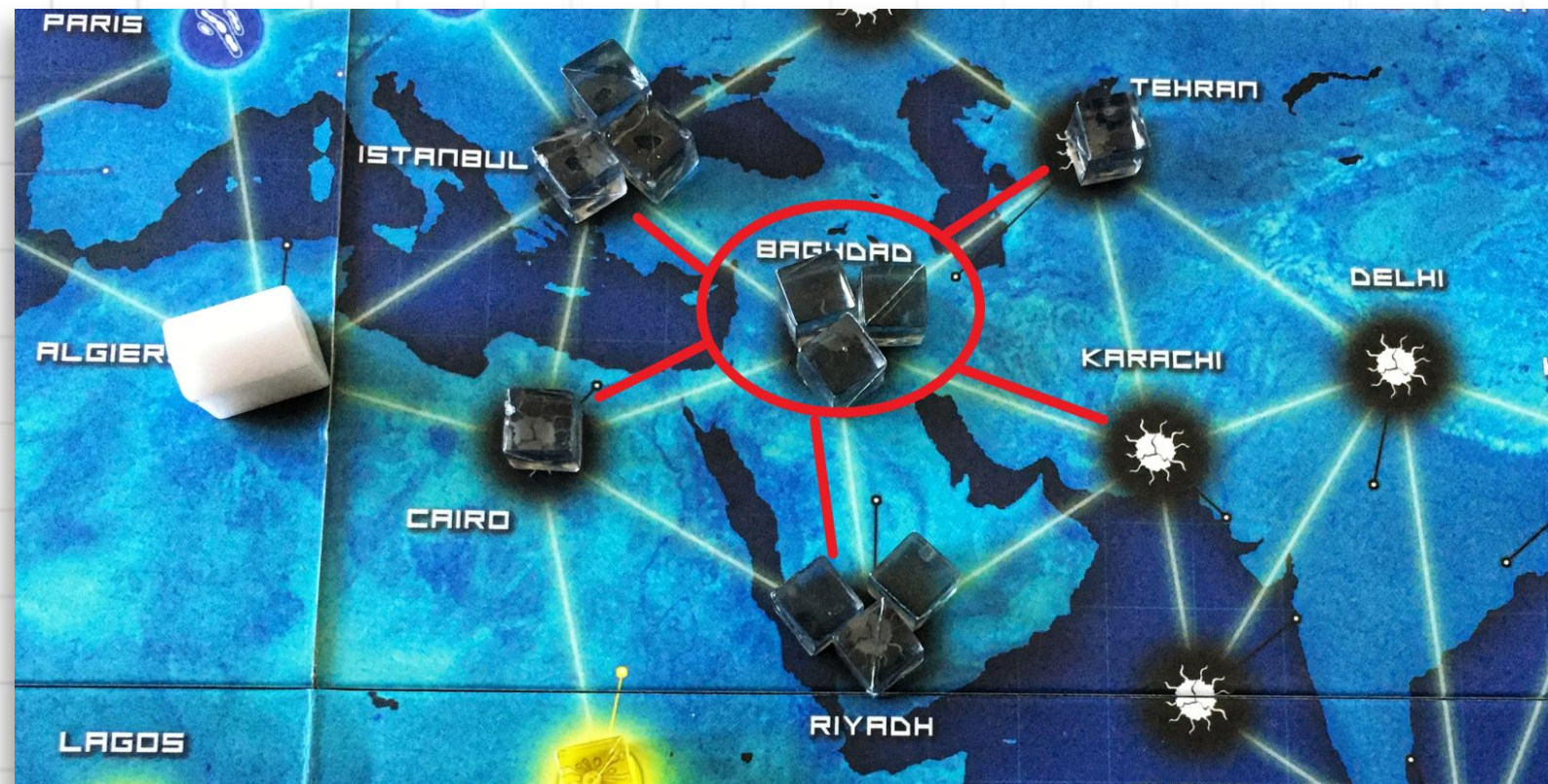
# Manipulating Decks

- ♣ Insert card into specific portion of deck
- ♣ Insert card into deck after some event occurs
- ♣ Put multiple copies of card into deck and remove the dupes after the first is found
- ♣ etc.





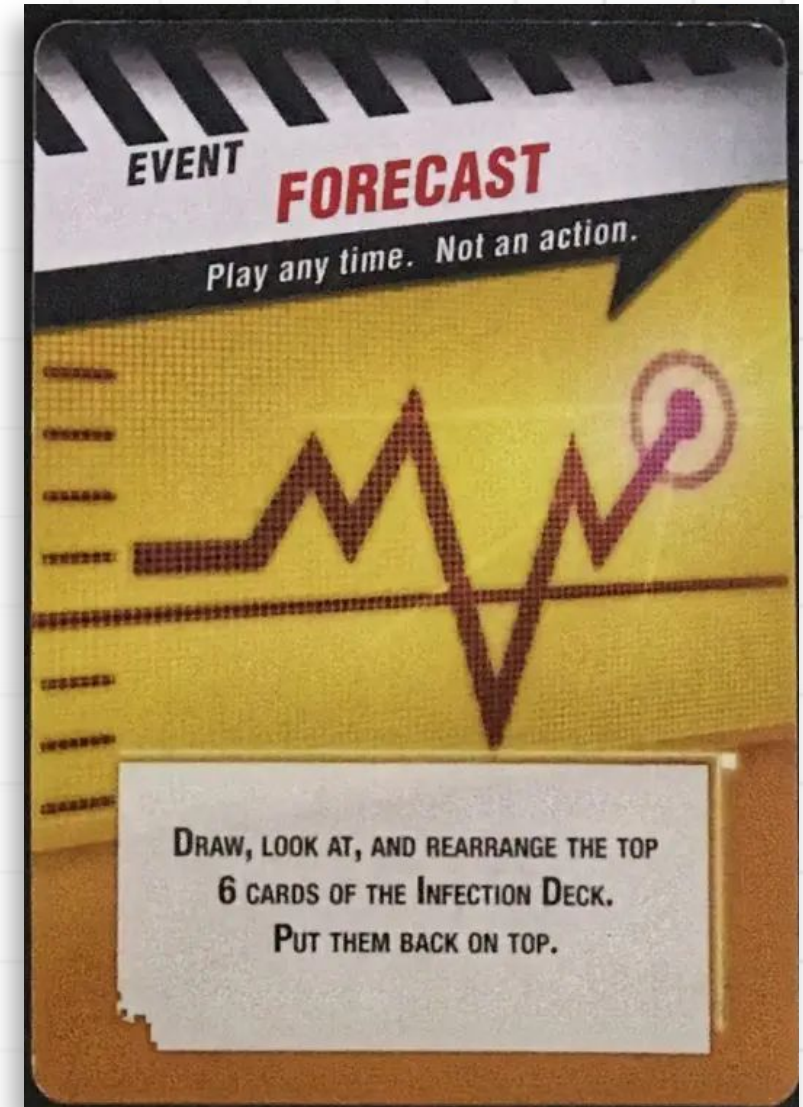
# Self-Regulating Randomness in *Pandemic*





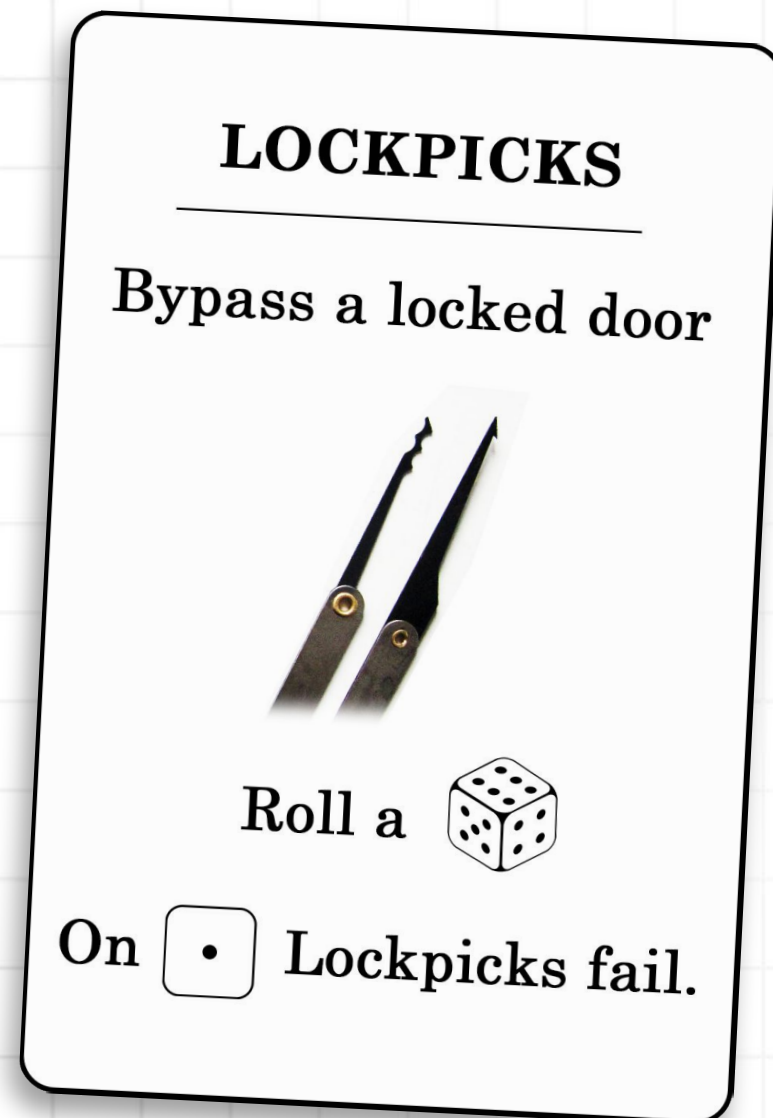
# Matt Leacock on *Pandemic*

- ♣ Cards instead of dice - “dice have no memory”
- ♣ Stacked decks
- ♣ Multi-use cards
- ♣ Input randomness
- ♣ Player tools to manage randomness →
- ♣ Playtest, iteration, observation
- ♣ Not tons of mechanics nor randomness





# Pitfalls to Be Wary Of



- ♣ Isolated/inconsistent random events
- ♣ One die (has maximum swinginess)
- ♣ Swingy events with large importance
- ♣ Cards with narrow applicability
- ♣ Decks with both positive and negative value cards
- ♣ 1 in 6 (may mislead psychologically)



# Uses for Randomness

- ♣ Drama (*celebration, frustration*)
- ♣ Variety
- ♣ Chaos, surprise
- ♣ Creates a planning horizon / foils planning
- ♣ Saves players from too much planning
- ♣ Fuels planning → Improvisation
- ♣ Tilts the playing field, dilutes player skill contribution





# Tools To Manage Randomness

- ♣ Don't use randomness at all, or use less of it
- ♣ Aggregate Randomness, Offsetting dice to avoid the number 1 (d6+4)
- ♣ Input vs Output Randomness
- ♣ Use cards instead of dice to control periodic events
- ♣ Player Choice, Multi-use cards
- ♣ Hierarchies of success/failure to monitor flow of randomness
- ♣ Manipulating die rolls: re-roll, add, subtract, transform, etc.
- ♣ Manipulating cards: search deck, rearrange cards, remove cards, etc.
- ♣ Traits to make cards more/less applicable
- ♣ Stacking decks / manipulating decks





# Thank You!

Randy Smith - [geminiradio@gmail.com](mailto:geminiradio@gmail.com)

## Uses For Randomness

- ♣ Drama (*celebration, frustration*)
- ♣ Variety
- ♣ Chaos, surprise
- ♣ Creates a planning horizon / foils planning
- ♣ Saves players from too much planning
- ♣ Fuels planning → Improvisation
- ♣ Tilts the playing field, dilutes player skill contribution

## Pitfalls to Be Wary Of

- ♣ Isolated/inconsistent random events
- ♣ One die (has maximum swinginess)
- ♣ Swingy events with large importance
- ♣ Cards with narrow applicability
- ♣ Decks with both positive and negative value cards
- ♣ 1 in 6 (may mislead psychologically)

## Tools To Manage Randomness

- ♣ Don't use randomness at all, or use less of it
- ♣ Aggregate Randomness, Offsetting dice to avoid the number 1 (d6+4)
- ♣ Input vs Output Randomness
- ♣ Use cards instead of dice to control periodic events
- ♣ Player Choice, Multi-use cards
- ♣ Hierarchies of success/failure to monitor flow of randomness
- ♣ Manipulating die rolls: re-roll, add, subtract, transform, etc.
- ♣ Manipulating cards: search deck, rearrange cards, remove cards, etc.
- ♣ Traits to make cards more/less applicable
- ♣ Stacking decks / manipulating decks





GDC

March 20-24, 2023  
San Francisco, CA

Random Number  
Generators

# Cards, Dice & RNGs: Using Randomness Intentionally

Design talk by Randy Smith  
Waves All Day *(that's my new studio)*  
[geminiradio@gmail.com](mailto:geminiradio@gmail.com)

#GDC23





# Randy Smith

- ♣ Designer / Director
- ♣ *Thief* series
- ♣ Ubisoft, EA, Hollywood
- ♣ Indie studio Tiger Style
- ♣ *JETT: The Far Shore*
- ♣ Current: Digital games with tabletop-like mechanics



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



GDC

I'm Randy, a game designer and director with 25 years experience. I've worked on first person immersive sims, in AAA, on indie platformers, always games that have strong fiction combined with an emphasis on game mechanics and systems. My new project I'm shopping around here at GDC is a digital game, an RPG, that uses cards and other tabletop mechanics.



# My Randomness Journey



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



About 6 years ago I started prototyping my own tabletop games. One design involved this lockpicks card - rather than find the long way around, you could play this card to get through a locked door, but you had to roll a die and on a 1 it wouldn't work.

This seemed like the kind of thing you do in a board game design - draw some cards that have player powers, roll some dice to see if they work.

Turns out this is a terrible design, all by itself it embodies some of the worst mistakes in randomness design.

What I learned was that my designer toolkit on randomness, an essential design tool, wasn't mature. And what's more my digital games were subject to some of the same problems, but under the hood in a way not visible to players.



# This Talk

- ♣ How randomness works
  - ♣ Survey of mechanics
  - ♣ Tools to manage randomness
  - ♣ Purpose of randomness in game design
- 
- ♣ Outline: Dice, then Cards

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



GDC

Since then I've been on a deep dive of randomization mechanics and how they work in both tabletop and digital games, and this talk shares my key takeaways, and it's meant to form a toolkit that's broad but applicable to day-to-day design problems. For me the important thing is applying randomness with intention: using it in a targeting way to serve your game design goals. ("Don't leave randomness to chance")

We'll talk first about Dice, then Cards as an overall sequence with digital games mixed in throughout



# Why Probability Is Important

- ♣ Randomness creates the contours of your gameplay
- ♣ Players will solve for those contours
- ♣ There may also be imbalances
- ♣ Probability math can reveal these properties without lots of testing, trial and error

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



There's a little bit of probability math in this talk. For many designers, I think it's worth studying to some depth in some capacity, but here in this talk if your eyes glaze over during those bits, that's okay. There are very successful designers who don't use these skills much.

I do want to say that the reason probability math is important is because once your game design touches randomness, that randomness necessarily will shape your game in ways that players will min/max and solve for, it may create places where things are unfair or too easy, and rather than intuition or exhaustive testing, probability math can be an efficient and thorough tool for revealing those qualities.



# Uncertainty

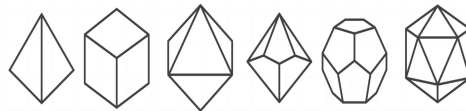
- ♣ Randomness
- ♣ Other players
- ♣ Not-yet-known content or mechanics
- ♣ State space too large / Systemic complexity
- ♣ Hidden information



And lastly, randomness is a type of uncertainty and there are other sources of uncertainty, like other players, some content like a level or a scenario that you've never played before, etc.. These sources of uncertainty accumulate - if you already have some in your game, you might need less randomness to achieve your goals.



# *Part 1: Dice*



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

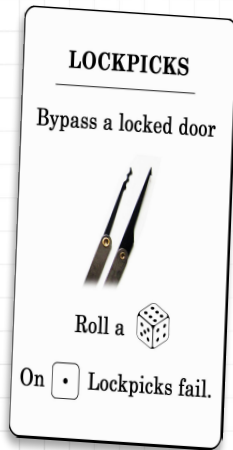


GDC

Let's start with dice.



# Aesthetics of this Die Roll?



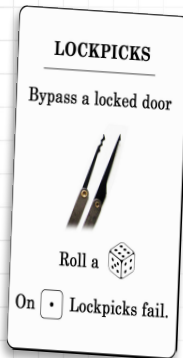
- ♣ Drama!
- ♣ Celebration / Victory
- ♣ Frustration / Failure
- ♣ What was the player supposed to do if they roll a 1?

Let's start interrogating the die roll on this Lockpicks card, which is essentially a skill check. What's it feel like? There's a moment of tension: You roll the die and yes! you got a 3, that was good enough, you bypassed the locked door. That is one of the major ways in which randomness can contribute to your design: it adds drama, little moments of victory and celebration. Conversely, when you fail your roll, they can add frustration and worry, which is equally important for drama.

However, the first moment of realization for me was playtesting my own game and the first time I shook a 1. I wasn't expecting it - I sort of assumed it would never happen. And what I learned was: well now what? What am I supposed to do now that my roll failed, what was I supposed to do differently? If failure is important to drama, what ingredients was this moment of failure lacking?



# Combat To-Hit Rolls



vs.



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



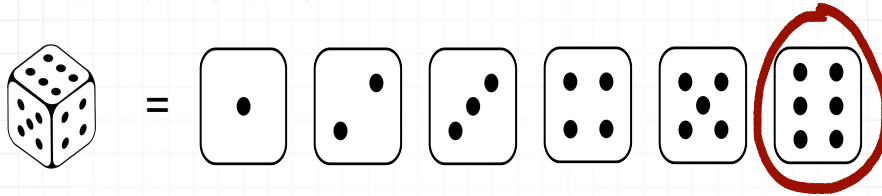
How about this question: If the lockpicks skill check is bad, then aren't to-hit rolls the same bad design over and over? Imagine a tactical combat game where you go toe to toe with an enemy and roll to hit and then roll for damage, just exchanging blows. How can these games be any good, if they're based on the same type of mechanic that's bad in the lockpicks card?

So to consider all this we'll talk about probability, distributions, predictability, and swinginess - the core topics around dice.



# Probability with one die

*"Roll a six."*

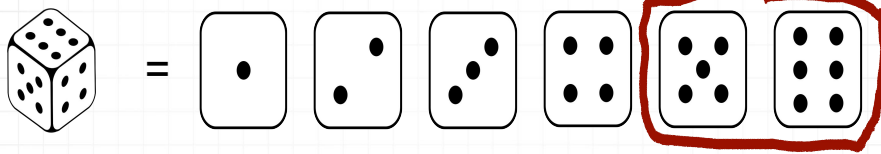


$$\frac{1}{6} = 16.\overline{6}\%$$

If you roll a standard six sided die and your goal is to roll a 6, that's a 1 in 6 chance, because all faces of the die are equally likely and there is only 1 result you are looking for out of 6 possibilities.

# Probability with one die

*"Roll a five (or higher)."*



$$\frac{2}{6} = \frac{1}{3} = 33.\bar{3}\%$$

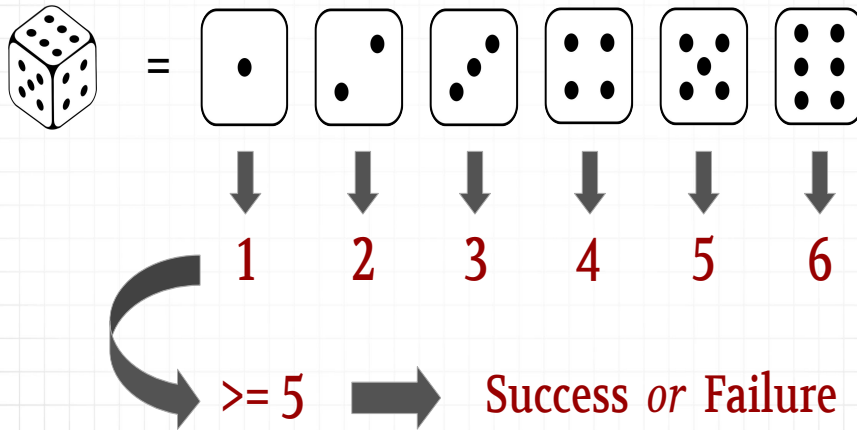


If you're trying to roll a 5, by which we usually mean roll a 5 or higher, then there are 2 of the 6 possible outcomes which meet the criteria.



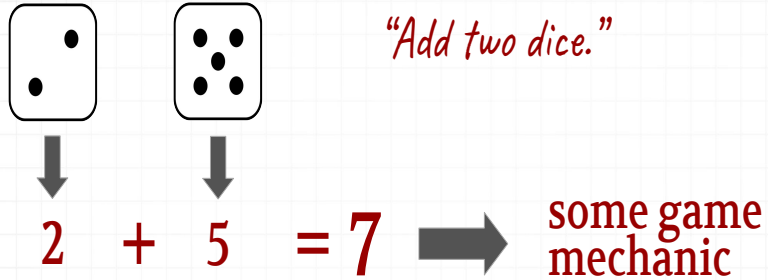
# Mapping

*"Roll a five (or higher)."*



So what we're doing here is mapping - first we map the number of pips on the die face to a digit, we do some mathematical operation on that digit, then we pass the result in to some game mechanic.

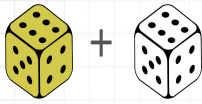
# Mapping



We do these kinds of mappings pretty automatically, it's a second nature to do something like roll two dice and sum them together.



# Aggregate: Adding two dice



|  | 2 | 3 | 4 | 5  | 6  | 7  |
|--|---|---|---|----|----|----|
|  | 3 | 4 | 5 | 6  | 7  | 8  |
|  | 4 | 5 | 6 | 7  | 8  | 9  |
|  | 5 | 6 | 7 | 8  | 9  | 10 |
|  | 6 | 7 | 8 | 9  | 10 | 11 |
|  | 7 | 8 | 9 | 10 | 11 | 12 |

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



GDC

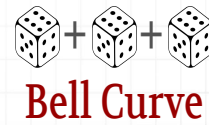
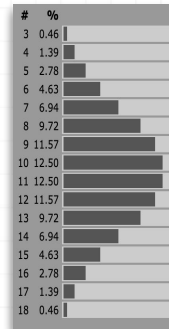
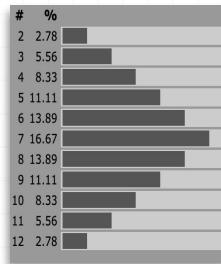
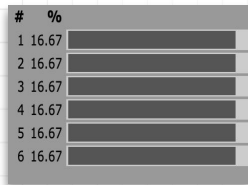
Summing two dice is an example of aggregating randomness. When you aggregate, the distribution of outcomes is no longer even - some outcomes are more common than others.

We use these kinds of tables, like this one that represents every possible outcome when you roll two dice and sum the results together.

Because all faces of each die are equally likely, each cell in this table is also equally likely. There is only one way to roll a 1 on the yellow die and a 1 on the white die, just like there is only one way to roll a 3 on the yellow die and a 4 on the white die.

But when we aggregate by summing the dice together, there are more ways to produce the outcome of a 7 than any other number. And there are the fewest ways to produce a 2 or a 12. So there are averages vs extremes.

# Distributions



In probability we talk about different distributions.

One die results in a flat distribution where all results are equally likely.

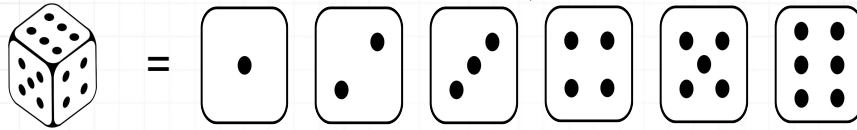
With two dice you get a pyramid distribution, so called because each step of the pyramid is the same size and the shape is a triangle with a sharp point at the average. In a pyramid distribution the extreme results like 2 and 12 still happen occasionally.

With three or more dice, you get the bell curve. The extremes are a lot less likely to happen, the expected results are a lot more likely to happen.

There are very many important implications of this...



# Expected Value



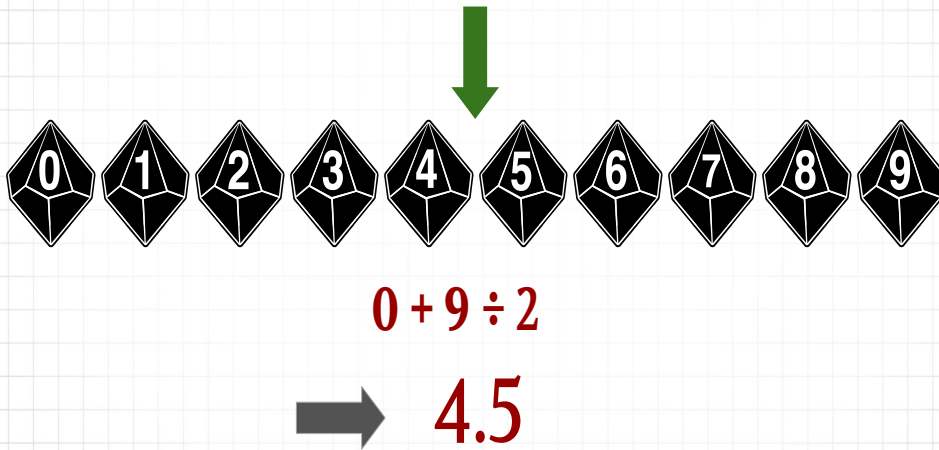
$$1 + 2 + 3 + 4 + 5 + 6$$

$$= 21 \div 6 \rightarrow 3.5$$

...but first let's also talk about expected value.

Expected Value is a useful tool which means essentially: if you rolled this dice thousands of times, what is the average result you would get. For a d6 the expected value is 3.5 which intuitively makes sense because it's right in the middle of the 6 possible outcomes. (I always think it's funny that we say it's the expected value of rolling a d6, though, since in reality you can never roll an actual 3.5, no matter how many times you roll it.)

# Expected Value



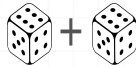
For any die whose output is a continuous sequence of integers (which is most dice), the shortcut to determining expected value is the lowest outcome+the highest outcome / 2, or again you can think of it as the middle point of all of the die's outcomes.



# Expected Value of Pool of Dice



3.5



$3.5 + 3.5 = 7$



$3.5 + 3.5 + 3.5 = 10.5$



If you want to know the expected value of a pool of dice, you can just sum the expected value of each individual die in the pool, so the expected value of 2d6 is 7, the expected value of 3d6 is 10.5, etc..

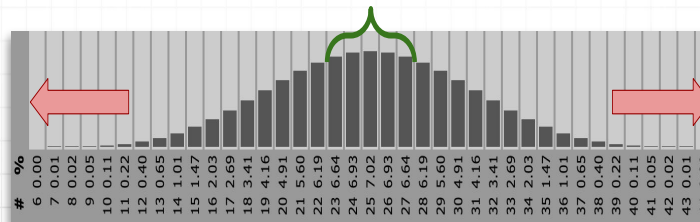
# Big Dice Pools “ $d4 + 2d6 + 2d8 + d12$ ”



$$1 + (2 * 1) + (2 * 1) + 1 = 6$$

$$2.5 + (2 * 3.5) + (2 * 4.5) + 6.5 = 25$$

$$4 + (2 * 6) + (2 * 8) + 12 = 44$$



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



What if you roll a whole bunch of dice, like these specific 6 dice.

You can use the tricks I've described to figure out the expected value - summing the expected value of each individual die. You can trivially find the minimum and the maximum. So now we know when we roll all these dice, we'll get something between 6 and 44, averaging 25.

The more dice you sum together, the more pronounced the behaviors are where the average results are common and the extreme results are rare. In this chart of the outcomes, the 12 most extreme results show up a combined total of less than 1% of the time. Whereas over  $\frac{1}{3}$  of the time, you're going to get one of these middle 5 results!

Takeaway here is that big dice pool look more random but counterintuitively behave less randomly.



# To-Hit Rolls = Aggregate



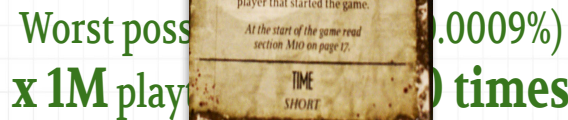
March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



GDC

So the reason that tactical combat games with many to-hit rolls are better than the lockpick example is specifically **BECAUSE** they roll the dice over and over. It's the same principle as a large dice pool, except instead of rolling the dice all at once, you roll the dice consecutively. More random events in both cases lead to more predictability.



Should you worry about that? It depends on what that bad roll means. Here's an example from Dead of Winter where the victory condition of the game, how many samples you have to collect, is determined based on die rolls. So once in a while you might get an extreme random result which could make the game unwinnable.



# More Aggregate → Vanishing Odds of Extreme Events

48d6  
(Min = 48)

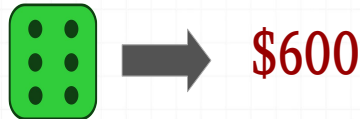


Any outcome less than 90  
**x 10T playthroughs = 1 times**



But in our tactical combat game, if you're rolling the dice dozens of times, there comes a point where you don't have to worry about the extremes. For example, if you were to roll 48 d6 dice, you'd have to roll ten TRILLION times to see a result less than 90 even once.

# Swinginess



So swingy is a word we use a lot when talking about randomness. It's the opposite of predictability and usually it's something we don't want too much of. An example would be rolling d6 to determine starting money. Let's say this is a roll that only happens once in the game and someone could wind up with 6x more than someone else - that might be really unfair and players might say this part of the game is swingy.

That suggests a way we can define or measure swinginess. How often two events produce results that are different by some factor like 3x or more.



# Swinginess of d6



are two  
results  
off by  
3x or  
more?

10/36

=

27.7%

|   | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 |   |   |   |   |   |   |
| 2 |   |   |   |   |   |   |
| 3 |   |   |   |   |   |   |
| 4 |   |   |   |   |   |   |
| 5 |   |   |   |   |   |   |
| 6 |   |   |   |   |   |   |

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

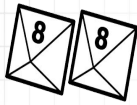


GDC

How often do you shake two dice and the two results are different by a factor of 3x or more? For a d6, that's 27.7% of the time.

Do you think a d8 is more swingy by this metric than a d6?  
And if so, how much more?

# Swinginess of d8



are two  
results  
off by  
3x or  
more?

**18/64**

**=**

**28.1%**

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 |   |   |   |   |   |   |   |   |
| 2 |   |   |   |   |   |   |   |   |
| 3 |   |   |   |   |   |   |   |   |
| 4 |   |   |   |   |   |   |   |   |
| 5 |   |   |   |   |   |   |   |   |
| 6 |   |   |   |   |   |   |   |   |
| 7 |   |   |   |   |   |   |   |   |
| 8 |   |   |   |   |   |   |   |   |

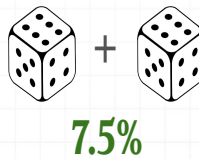
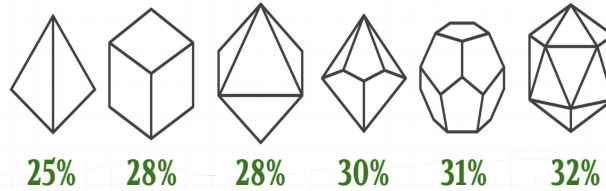


Turns out it's not that much more, just a fraction of a percentage point.



# Swinginess

as measured by how frequently it produces adjacent results that are off by 3x or more



In fact, by this metric all of the dice are surprisingly similar in swinginess.

However 2d6, because of those principles of aggregate randomness, is much lower than all of them, because it predictably tends to produce 7s and so rarely produces 2s or 12s.

# Swinginess of d6+4



are two  
results  
off by  
3x or  
more?

0/36

=

0%

|    | 5 | 6 | 7 | 8 | 9 | 10 |
|----|---|---|---|---|---|----|
| 5  |   |   |   |   |   |    |
| 6  |   |   |   |   |   |    |
| 7  |   |   |   |   |   |    |
| 8  |   |   |   |   |   |    |
| 9  |   |   |   |   |   |    |
| 10 |   |   |   |   |   |    |



Aggregate randomness is not the only way to curtail swinginess. Part of the problem with a normal d6 or other die is that it starts with a 1. So if you add an offset to it, such as d6+4, when you perform the swinginess calculation, the numerator and divisor get closer together, and viola here is the chart of all the places d6+4 is swingy by 3x or more: zero places.



# Swinginess of d6+4



are two  
results  
off by  
2x or  
more?

2/36

=

6%

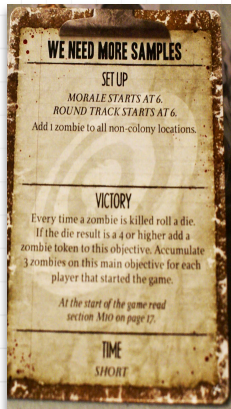
|    | 5 | 6 | 7 | 8 | 9 | 10 |
|----|---|---|---|---|---|----|
| 5  |   |   |   |   |   |    |
| 6  |   |   |   |   |   |    |
| 7  |   |   |   |   |   |    |
| 8  |   |   |   |   |   |    |
| 9  |   |   |   |   |   |    |
| 10 |   |   |   |   |   |    |



If you make the test more sensitive, down to 2x, there are still only a couple instances on the extremes.

So using an offset like d6+4 does a lot to curtain swinginess, and is different than aggregate randomness because it uses that flat distribution - all possible results are equally likely, and that might be what you want.

# Importance of Events



\$100

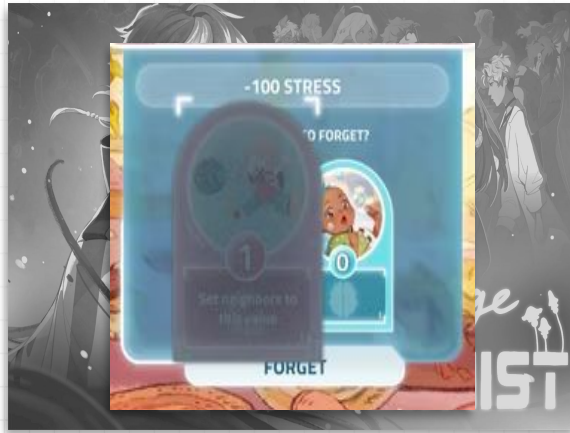


\$600

Some events have more importance or weight than others, for example that random victory condition because it can eclipse the importance of the other random events, and your game design is going to as swingy as its weakest link. You can imagine the thought experiment of this taken to an extreme: a super well balanced game where at the very end you flip a coin to see who wins. In the case of starting money, it has both problems: it's heavily weighted with importance, and it uses just one very swingy, unpredictable die.



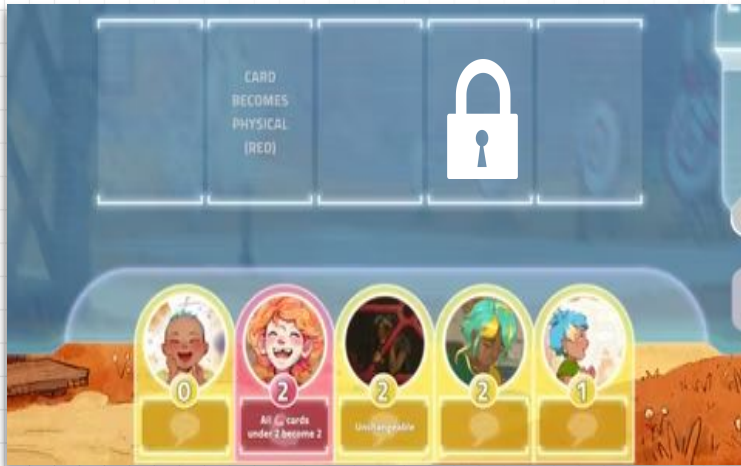
# Event Weight in *Exocolonist*



Sarah  
Northway  
of *Rebuild*,  
*Exocolonist*,  
etc.

Sarah Northway is one of my favorite designers and in her “indie masterpiece” (according to Destructoid), *I Was A Teenage Exocolonist*, she had to consider and manage outlier random events with a lot of weight. One example was occasions when the player got to pick a card to remove from their deck, which in a deckbuilder like this is an important event because it can significantly increase the power of your deck. Rather than leave that up to pure randomness, which might present to the player two cards chosen at random that they would never want to discard, instead ONE of the cards was chosen purely at random, the other always comes from the bottom half of the player’s deck, where the weaker cards are. (To prevent players savescumming, which is a worry in digital games, she used a random number seed, which means if you reload to try again, you’ll still be presented with the same two cards.)

# Event Weight in *Exocolonist*



Sarah  
Northway  
of *Rebuild*,  
*Exocolonist*,  
etc.

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



Another moment of weight was a game mechanic where a card chosen at random would get locked in your solution - if this was a strong card, it would make the overall puzzle much easier, if it was a weak card, much harder. In this case, Sarah DID use pure randomness - she liked there was some chaos to how challenging these puzzles were, and it was balanced elsewhere by Dynamic Difficulty Adjustment that tracked the player's overall success at these games.



# Event Weight in *Exocolonist*

“...walk a line between fun randomness and frustrating randomness, and hide our manipulation so players don't feel too coddled.”



Sarah  
Northway  
of *Rebuild*,  
*Exocolonist*,  
etc.

Sarah's goal was to “walk a line between fun randomness and frustrating randomness, and to hide our manipulation so players don't feel too coddled”

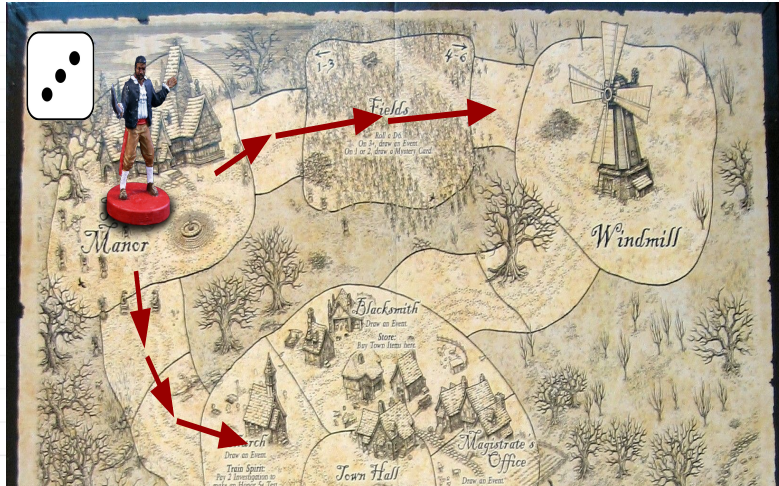
# Takeaways So Far

- ♣ Aggregate Randomness Leads to More Predictability
- ♣ Isolated Random Events Are More Swingy  
(one die = max swinginess)
- ♣ Very Rare Events Sometimes Happen
- ♣ Be Conscious of Events With More Importance/Weight

Here's what we've talked about so far - if you want results to be more predictable, aggregate more random events. And if you don't want your game to be swingy, then watch out for isolated random events - specifically rolling a single die one time in isolation from other random events. That even very rare events sometimes happen, although they become vanishingly rare when you aggregate LOTS of random events. But watch out for random events that have more weight in the overall game design, your game will still be swingy if these events are swingy.



# Area Movement in *Touch of Evil*



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

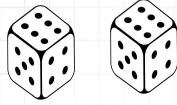


Let's start putting these ideas into practice with the classic mechanic of rolling dice to move around a board, such as in this game, *Touch of Evil*. If I'm here at the Manor and I roll a 3, I can't quite make it to the Windmill with that roll, and I also can't quite make it to the Town Hall or Blacksmith. So (assuming there's nothing useful for me to do unless I get to my destination) movement becomes a gatekeeper for other player affordances and verbs. If I NEED to go to the windmill and I roll a 3, I've essentially lost a turn, impacting game balance and player enjoyment.

And it's actually possible that you could get bad rolls and lose TWO turns.

(mini: Bonepile Miniatures)

# Area Movement in *Touch of Evil*



shake 3 or less total  
after 2 rolls

$$\frac{3}{36} = 8\%$$

|  | 2 | 3 | 4 | 5  | 6  | 7  |
|--|---|---|---|----|----|----|
|  | 3 | 4 | 5 | 6  | 7  | 8  |
|  | 4 | 5 | 6 | 7  | 8  | 9  |
|  | 5 | 6 | 7 | 8  | 9  | 10 |
|  | 6 | 7 | 8 | 9  | 10 | 11 |
|  | 7 | 8 | 9 | 10 | 11 | 12 |

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



GDC

We can use this familiar graph to think about how likely it is you would get 3 movement points or less after 2 rolls. Two dice gives us the pyramid distribution where the extreme results still happen occasionally - 8% seems to me too high a chance to lose 2 turns in a row.



# Mods to Movement Rules



5



choose  
one



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



Common mod to this game: no randomness just 5 movement. My mod = roll 2 die and the player gets to select whichever one they prefer.

# Player Choice



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



Player choice is a great tool to manage randomness, because the player will always (or at least tend to) pick the option that benefits them best given their current circumstances. When you're trying to benefit the player, but it's a complex problem to figure out exactly how, you can just offer them a choice. This companion in Lost Ruins of Arnak allows you to choose which resources you'll get - the player knows best which one they need most and if they make a bad choice they blame themselves instead of you. Dead of Winter has a cool searching mechanic where you can draw more cards to select between, but it's at the risk of attracting more zombies. This Arkham Horror encounter card lets the player choose the penalty they suffer, so they'll pick the penalty that's least bad for them. So: player choice has a normalizing effect, which reduces swinginess by allowing the player to filter out the negative extremes - it always inures to the benefit of the player.



## 2-Choose-1



choose  
the  
highest

$$\frac{27}{36} = 75\%$$

|  | 1 | 2 | 3 | 4 | 5 | 6 |
|--|---|---|---|---|---|---|
|  | 2 | 2 | 3 | 4 | 5 | 6 |
|  | 3 | 3 | 3 | 4 | 5 | 6 |
|  | 4 | 4 | 4 | 4 | 5 | 6 |
|  | 5 | 5 | 5 | 5 | 5 | 6 |
|  | 6 | 6 | 6 | 6 | 6 | 6 |



So coming back to rolling 2 dice and choosing 1, it's a pretty reductive mechanical process of just choosing the higher die, and it skews towards higher outcomes. It turns out you'll get a 4 or better 75% of the time now, a big improvement over 50% of the time.

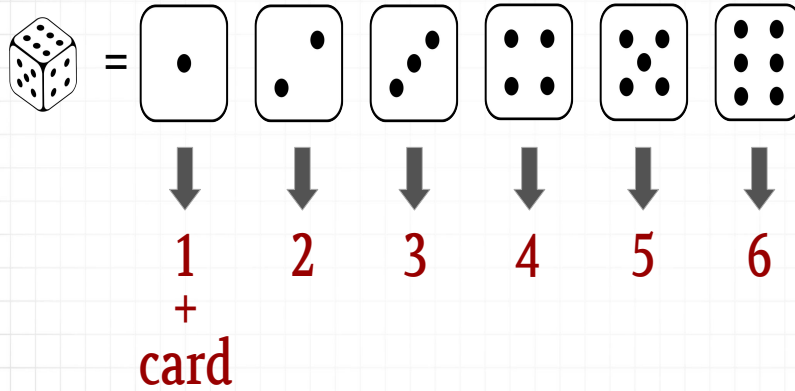
# Rolling a 1 in *Touch of Evil*



In the actual game *Touch of Evil* if you roll a 1, you get to draw an event card as a consolation prize. A couple observations...



# Expected Value



...one is that it complicates how to think about expected value, because now to determine which of these rolls is the best, you need some way to convert between movement points and cards...

# Adding player choice



choose  
one

offers choice between 1  
(card) and 2-6

$$\frac{10}{36} = 27.8\%$$

|  | 1 | 2 | 3 | 4 | 5 | 6 |
|--|---|---|---|---|---|---|
|  | 2 | 2 | 3 | 4 | 5 | 6 |
|  | 3 | 3 | 3 | 4 | 5 | 6 |
|  | 4 | 4 | 4 | 4 | 5 | 6 |
|  | 5 | 5 | 5 | 5 | 5 | 6 |
|  | 6 | 6 | 6 | 6 | 6 | 6 |

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



GDC

.. but more importantly, it reveals the real purpose of my mod, which is that it adds player choice. These are all the occasions in which the player is given a choice between drawing a card -or- moving further, these choices are offered more than 25% of the time.



# Aesthetics of these 2 mods?



Let's compare these 2 game mods: how does it feel when there is NO randomness? What's potentially good is that players all have the same movement resources to apply - it's fair.

WITH randomness it might not be fair, but what does that add? You might be gleeful if your opponent gets a bad roll, you might groan if they are better than you at the game and on top of that keep getting better dice rolls than you. So randomness can tilt the playing field for better or for worse, but always in a way which dilutes the contribution of each individual player's skill level.

# Tilting The Playing Field Can Be Good



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

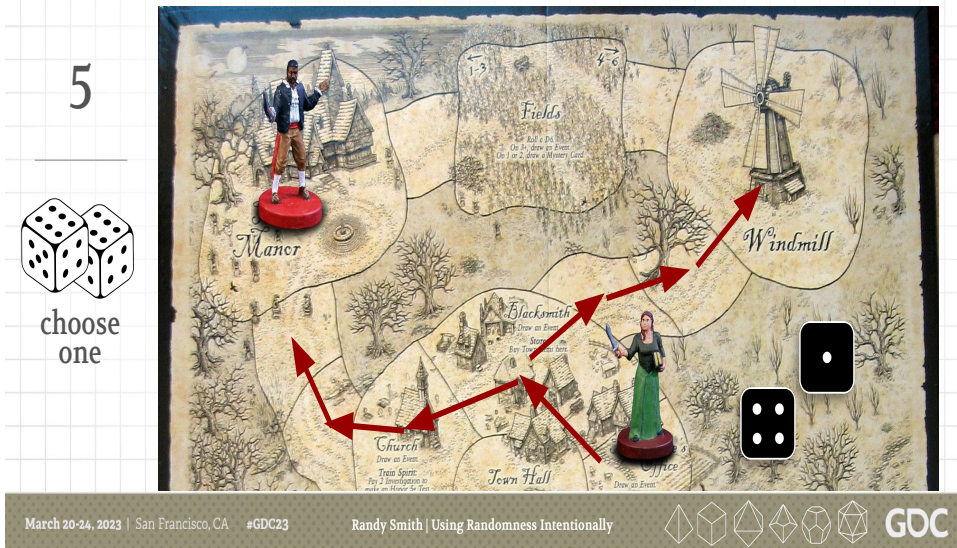


GDC

My family plays cards and our most enduring games use randomness to tilt the playing field. The idea is that you play your best with the cards you're dealt, but the luck of the draw plays a big role in determining who wins, so: you get to groan and gloat, the same person doesn't win every time, it's competitive but not cutthroat. These are games that we can play over and over for an entire lifetime.



# Aesthetics of these 2 mods?



Another observation is about planning: Let's say I'm trying to make it to the Manor, but I shake a 1 and a 4. A 4 isn't enough to get me to the Manor this turn, so my plan has been foiled. Now I can improvise: go to the Windmill or the Church instead? Get as close to the Manor as I can? move 1 and draw a card? The rhythm of planning and then improvising is one of my favorite things about games, and without uncertainty it doesn't exist - uncertainty of some kind is always required. If the player has perfect information, they will never plan incorrectly, they will never need to replan.

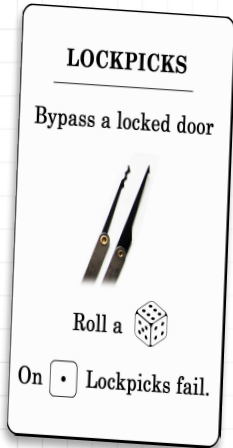
# Uses for Randomness

- ♣ Drama (*celebration, frustration*)
- ♣ Tilts the playing field, dilutes player skill contribution
- ♣ Defeats player planning
- ♣ Planning → Improvisation
- ♣ ...

This is what we've talked about so far, but we'll keep filling this thing out. Randomness is good for Drama, it has the potential to tilt the playing field which can dilute the contribution that being a skillful player makes, it can defeat the player's plans and therefore fuel the cycle of planning and improvisation.



# Psychology of Swinginess



- ♣ What if it fails on 1 in 2 instead?
- ♣ What about 1 in 10?
- ♣ 1 in 6 may be the worst odds in terms of psychology versus actual math

Coming back to the lockpicks card, can we fix it by changing the odds? Is there something wrong with the 1 in 6 chance?

Would it be different if it failed on 1 in 2 instead? Yes. You'd think "these lockpicks aren't very reliable, I better have a backup plan."

What if they failed on 1 in 10 instead? This is very subjective but I believe that 1 in 10 feels similar to 1 in 6 - probably it's going to work, so don't stress about the possibility of failure. BUT a 1 in 6 is actually significantly more likely to fail than a 1 in 10. Any other dice, even 1 in 4, 1 in 8, I think will give the player a more accurate intuition about the odds.

# Tentacle Token in *Arkham Horror LCG*



- ♣ Players commit resources to try to pass tests
- ♣ Then draw a token
- ♣ Tentacle token = auto fail

In Arkham Horror LCG when you make a skill check you draw a random token. And then you compare the resources you've committed to the test versus the modifier on the token to see if you've passed. However there is one special token that always causes you to fail no matter what.

This seems like the same problem as the Lockpicks card, so why is it much better game design? One reason is that it happens with different odds than 1 in 6, usually more like 1 in 16, so that helps.



# Tentacle Token in *Arkham Horror LCG*



- ♣ No consistency across game
- ♣ Isolated
- ♣ 1 in 6

- ♣ Ubiquitous
- ♣ Creates a pervasive environment to adapt to
- ♣ 1 in 16+

A more important reason is ubiquity. Tests happen frequently throughout the game and they all use this same mechanic, so players learn that this is the environment you exist in, where anything you attempt could be foiled, you adapt to it: you should always have a backup plan to your backup plan, or else be prepared to improvise your way out of a tough situation. And the aesthetic of desperation that leads to, of never being safe from a bad thing happening, is what they were going for. By contrast, the Lockpicks card isn't part of any consistency you can adapt to: it's a one-off.

# Interventions in the flow of combat



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



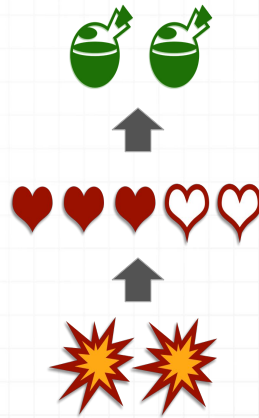
GDC

Similarly there is an aesthetic created in tactical combat games. I described them in a very mechanical, reductive way of just rolling die until someone dies, but in reality that prevalence of randomness creates the environment and the player's job is to monitor the flow of randomness, how it's going, and decide when to intervene by drinking a potion or casting a protection spell or running away, etc..



# Hierarchy of Failure

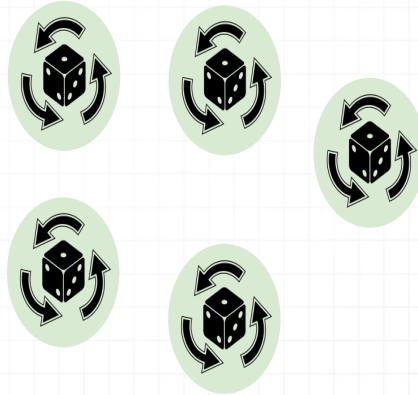
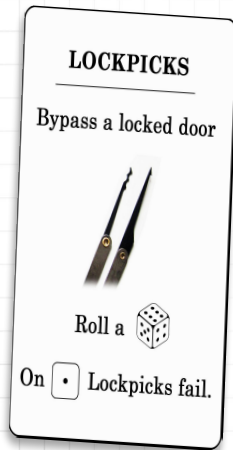
- ♣ Potions are an intervention
- ♣ They are also an early warning system
- ♣ Staggered failure like this is a tool for the player to monitor and manage randomness



How does the player monitor that flow, so they know when to intervene? Like most games, there's a failure hierarchy: as the dice rolls go badly, you lose health points. When those health points get low, you may decide it's time to intervene with a potion. When you're running out of potions, you may need to take more drastic steps.

These hierarchies make failure less brittle and allow the player to make better informed decisions.

# Adding Hierarchical Failure



To improve the Lockpicks card, let's say it's in a game where the player has a number of tokens they can use to re-roll any die roll in the game. This would be an improvement in several ways: the tokens create ubiquitousness, instead of one isolated die roll it's connected to a mechanic that applies across the entire game, the tokens obviously give the player the very direct tool of being able to re-roll a result they don't like, it gives the player the choice of when to apply that tool, and it forms a failure hierarchy / early warning system. If you're low on re-roll tokens as you approach a locked door, and your Lockpicks don't work - you can blame yourself instead of the swinginess of the game.



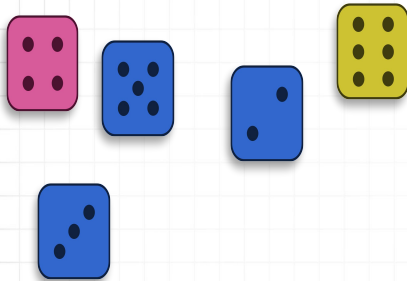
# Tools To Manage Randomness

- ♣ Aggregate Randomness
- ♣ Player Choice
- ♣ Hierarchies of success/failure to monitor flow of randomness
- ♣ ...

This is what we've talked about so far, but we'll keep filling this thing out.

Aggregate Randomness is a design tool for controlling probability distributions, Giving the player choices helps in various ways, and Giving the players a way to monitor how well they are doing before they fail.

# *One Deck Dungeon*



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



So far we've talked about wanting to do something, then rolling the dice to see if you can do it. There are other ways to use dice.

In One Deck Dungeon, you have to overcome a challenge composed of several tasks. You roll a bunch of dice, and then you complete the tasks by assigning dice - you need to both match the color of the die to the color of the task and the die must have a high enough result to fulfill the task. This is a pretty obvious matching activity, but by itself usually it's not enough to overcome the challenge.

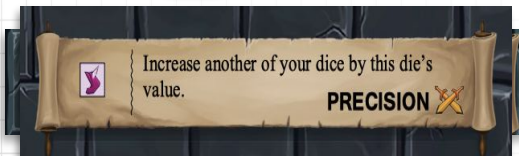
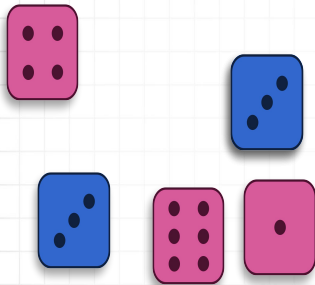


# Tools to Control Randomness



You also have skills and potions which are tools for manipulating dice rolls in very direct ways: with rerolls, changing colors, modifying outcomes, adding more dice, etc..

# One Deck Dungeon



March 20-24, 2023 | San Francisco, CA #GDC23

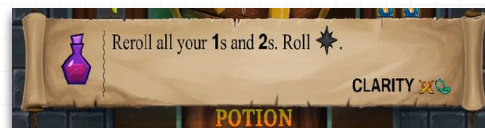
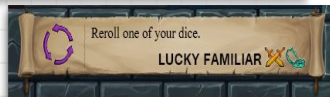
Randy Smith | Using Randomness Intentionally



The overall vibe is that the challenge you are facing, plus the dice you roll, plus the special abilities you have combines to create a dynamically-generated puzzle for you to solve. And sometimes it can be kind of mechanical: there often is a single optimal solution for you to find.



# One Deck Dungeon



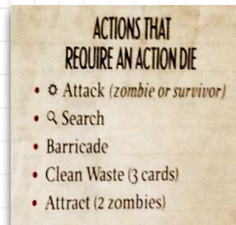
March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



But there is meaningful player choice in a few places: when there is no optimal solution you choose which optional tasks to fail and therefore which consequences to suffer. On the metagame level: you can choose which challenges do you want to take on. As you defeat challenges: how to level up your character with more dice and more skills. When to use one-shot potions, as an intervention.

# Dead of Winter



In the game *Dead of Winter*, you roll a certain amount of “action dice” so-called because you use them to take actions. You can activate an ability by spending a die that’s high enough, and when your dice aren’t high enough, you can activate lesser abilities with any die, no matter its value.

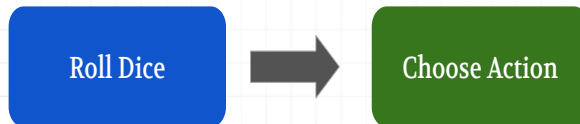


## Output Randomness



Geoff  
Engelstein  
of *Ludology*,  
*GameTek*,  
*McDie*, etc.

## Input Randomness



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



Both games use Input Randomness instead of Output Randomness. This is a major takeaway and a huge design tool. Shoutout to game designer Geoff Engelstein who gave an entire GDC talk on this a few years ago and who is a scholar of randomness in game design and offers many resources you should look into.

Output Randomness is when you choose which action to take, then roll the dice to find out if it worked. Input Randomness is when you first roll the dice and then based on what you got decide which actions to take.

A very familiar example of input randomness is with cards: typically you draw your hand of cards, and then you figure out what you're going to do with them.

Input randomness doesn't change the odds, but it allows the player to respond to the results at a different time, one that typically allows for more intentional planning. In other words, Input Randomness provides uncertainty without defeating player planning quite as much.

Like my Lockpicks card, Output randomness is often the

go-to default for game designers, but it's very much worth stopping to consider that choice mindfully.



# Rogue-likes as Input Randomness



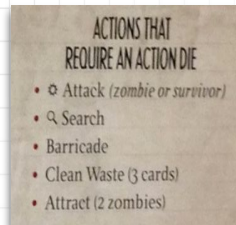
March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



Roguelikes are an example of input randomness in digital games: they randomly generate a challenge for the player to solve, much like rolling the dice in One Deck Dungeon. They create variety, which is one important use of randomness: you don't have to play with the same level, same board, same powers every time.

# Dead of Winter



Actions  
left:  
2



Input Randomness has a big effect on game aesthetics.

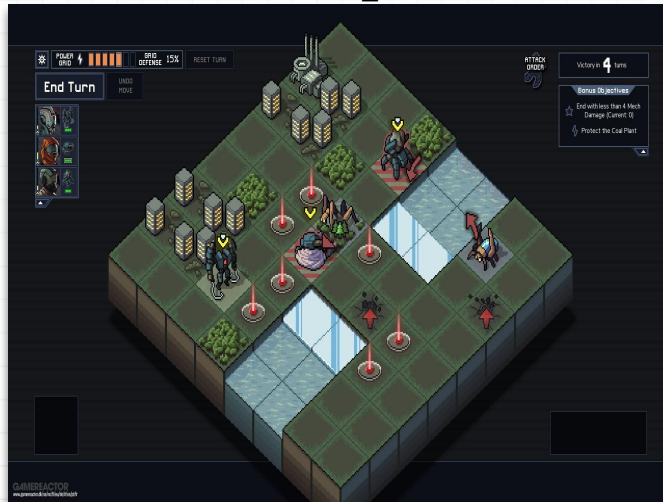
If DOW used output randomness, it would be like skill checks in another game where you declare your intent to take an action then check to see if you succeeded or not.

But DOW is a cooperative game. And co-op games often want you to achieve a high bar in planning, forcing you to work together. Using input randomness instead of output randomness here allows for both unpredictability AND planning.

Furthermore DOW is a semi-cooperative game where someone might be a traitor, so the fact that you KNOW someone has the ability to accomplish a task becomes important to figuring out who the traitor is.



# *Into The Breach* as Input Randomness



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



The game *Into The Breach* is a tactical combat game but it uses input randomness instead of output randomness. The only randomness is which monsters and similar game mechanics appear on the board each turn and how they behave. Otherwise everything else is deterministic, not random - this includes your attacks, how much damage they do, how other mechanics interact. Because there is no randomness to limit planning, it's a very tactical game. But mostly just one turn at a time - the input randomness refreshes the board each turn with a new tactical puzzle.

# Chess has no randomness



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

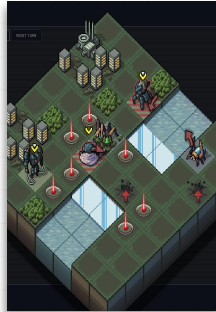


GDC

The extreme of this is chess - with no randomness, you are incentivized to think many many moves ahead, creating a very strategic and cerebral aesthetic. That may or may not be what you want for your game.



# Randomness creates a “planning horizon”



**Little randomness:  
Plan future moves**

**Much randomness:  
Plan less far out**

One way to think about this is how far into the distance you can meaningfully plan. In many games, there's no point in planning what you'll be doing 3 rounds from now, you just need to wait to see what the random situation will be then. When games are more predictable, you actually should be thinking about the next round and to some extent the round after it. Randomness can be used to “save players from themselves” as game designer Soren Johnson puts it, creating a fog that makes it pointless to try to plan too far out. Put another way: it prevents analysis paralysis.

# Uses for Randomness

- ♣ Drama (*celebration, frustration*)
- ♣ Tilts the playing field, dilutes player skill contribution
- ♣ **Creates a planning horizon**
- ♣ **Saves players from too much planning**
- ♣ Planning → Improvisation
- ♣ **Variety**
- ♣ ...



This used to say “defeats player planning” but if we describe it as a planning horizon it better captures why that might be good. And we’ll add this point that less planning saves players from themselves, that in addition to fueling improvisation.

We also added Variety at the bottom.



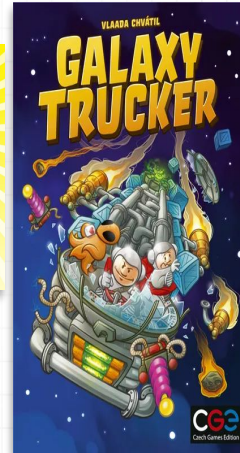
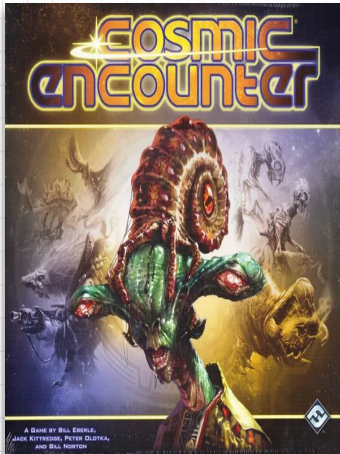
# Tools To Manage Randomness

- ♣ Aggregate Randomness
- ♣ Input vs Output Randomness
- ♣ Player Choice
- ♣ Hierarchies of success/failure to monitor flow of randomness
- ♣ **Manipulating die rolls: re-roll, add, subtract, transform, etc.**
- ♣ ...



And we've also added these very direct tools to manage randomness.

# Chaos and Surprise



March 20-24, 2023 | San Francisco, CA #GDC23

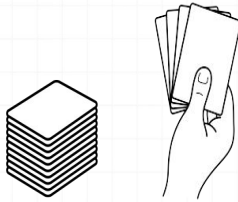
Randy Smith | Using Randomness Intentionally



I'll also point out that sometimes you don't want to manage randomness, the chaos of randomness itself is one of the things that makes the game fun.



# *Part 2: Cards*



March 20-24, 2023 | San Francisco, CA #GDC23

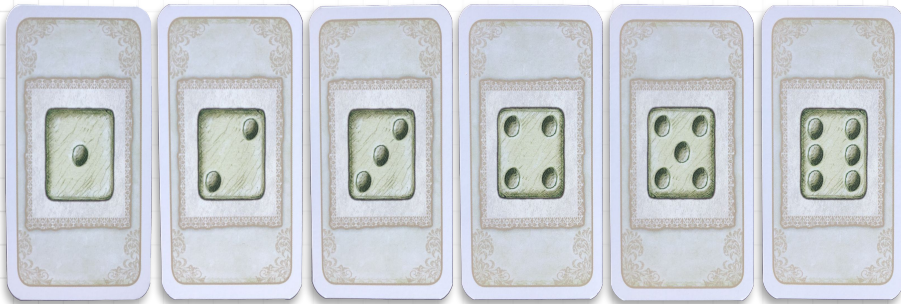
Randy Smith | Using Randomness Intentionally



GDC

Let's talk about cards. Cards fortunately build on most of what we've talked about already.

# Deck of “Dice Cards”



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



GDC

Imagine a deck of just 6 cards that show dice 1-6



# Deck of “Dice Cards”



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



GDC

if you deal one, then put it back in the deck and shuffle, it's the equivalent of rolling a die - there might be repeats, it might take a very long time before you see every possible outcome, etc.. In probability we call this “sampling with replacement” because we replace the card back in the deck before we take another sample. That's also what we call rolling dice.

# Deck of “Dice Cards”



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

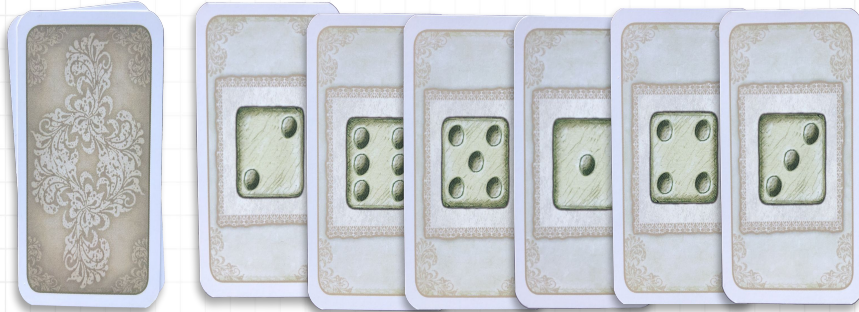


GDC

Instead, if you deal out the entire deck you'll eventually see every number 1-6...



# Deck of “Dice Cards”



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



GDC

... and you will never get any repeats. In probability we call this “sampling without replacement” because the drawn cards do not get replaced in the deck.

# Dice vs Cards



Pure  
Randomness      No  
Memory

Random  
Distribution      Sampling with  
Replacement



Controlled  
Randomness      Has  
Memory

Even  
Distribution      Sampling  
without  
Replacement

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



And this is the fundamental difference between dice and cards. I think of this as pure randomness vs controlled randomness. Matt Leacock, the designer of Pandemic, talks about how dice have no memory but cards have memory. Dice distribute outcomes all over the place, cards can enforce that all outcomes show up at least once.

Tons of implications.



# Takeaway Use Cards Instead of Dice

(or consider doing so)

March 20-24, 2023 | San Francisco, CA #GDC23

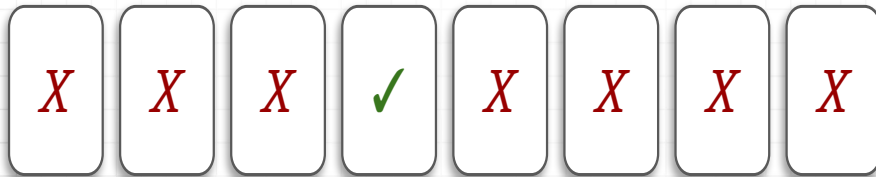
Randy Smith | Using Randomness Intentionally



GDC

Here is a very big takeaway: a lot of the time, you can get what you want by using cards instead of dice. Let's examine.

# Use Cards Instead of Dice



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

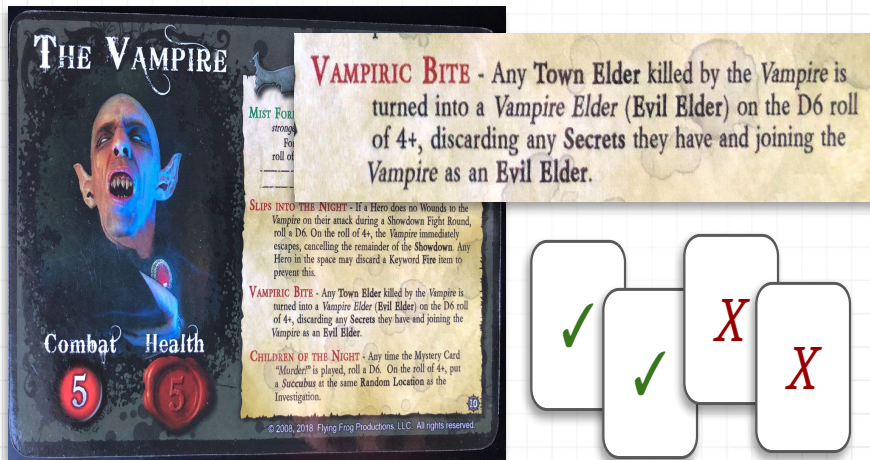


GDC

Let's say when players open treasure chests you want there to be something especially good at random 1 out of 8 times. If you roll a die, some players will get more, some will get less. But instead you can have a deck of cards under the hood with 1 yes card corresponding to the good treasure, and 7 no cards corresponding to normal treasures. After all 8 chests are opened, you shuffle the deck and start again. There is still unpredictability but periodic behavior of 1 in 8 times is enforced.



# Use Cards Instead of Dice



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



In Touch of Evil, the villains have special abilities that happen 50% of the time. But the game uses a die roll, and these events aren't triggered often enough to benefit from aggregate randomness, so in practice sometimes you never see this cool thing that gives the villain flavor, or other times it might happen too often and impact game balance. So instead of rolling a die, you can draw from a deck that has an equal amount of yes/no cards. This deck has a memory - if the special ability didn't happen last time, it's more likely to happen the next time.

# Use Cards Instead of Dice



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



Gloomhaven uses an attack modifier deck instead of dice: Your attack always hits, but these cards modify how much damage it does (potentially down to 0 damage which represents a miss).

Why use these? One reason is that it controls distribution, it enforces a balance of good and bad outcomes. Another is that card counting allows the player to do some planning: if they haven't gotten a good outcome in a while that means the deck is getting concentrated with good outcomes and they will get one soon.



# Digital Games Can Use...

- ♣ ...many decks.
- ♣ ...very large decks.
- ♣ ...complex nested decks that refer to each other.

In the tabletop space, this technique adds components and complexity for the player. But it's a great match for digital - especially when it's internal only, player doesn't see the deck, there's almost no cost.

# Use Cards Instead of Dice



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



One of the concepts in my game is that you can draw a tarot card at the beginning of each day to understand what unseen forces are acting upon you that day.

And similar to tarot cards in real life, they are sometimes randomly drawn upside-down, which inverts their meaning to something dangerous or bad. It would be too swingy to subject this to pure randomness, so instead I have a separate deck the player never sees whose job is to determine whether the card just drawn appears inverted. By tweaking this deck I can control exactly how frequently.

So I'm using randomness for variety, and also to drive some improvisation - the player might draw a card that tells them today they have a great opportunity to complete some goal they didn't already have in mind.

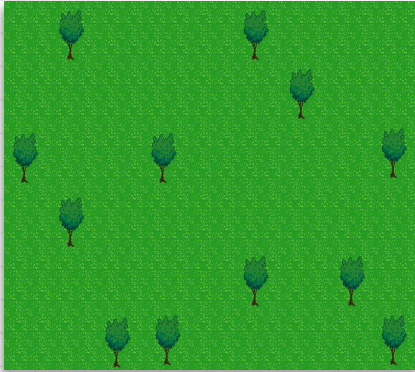
To be clear, I the designer used my intuition first when designing these mechanics; I think it's fine to do that and then use an analytical process for validation.

There are many ways you can accomplish these mechanics in the digital space, but I literally do implement them as a

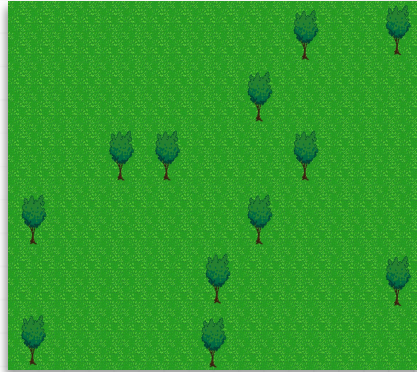


deck of cards, in the sense that they are an array of data structures that I shuffle and move between draw piles and discard piles, etc..

# Procedural Generation



Even distribution  
(cards)



Random distribution  
(dice)

You can use these principles in procedural generation - one of these places trees by drawing locations from a deck of cards for each 3x3 block. The other just places trees totally randomly. Not that one is necessarily better - it's just that how you populate the world leads to different visual results and different gameplay results.



# Transparency to the Player



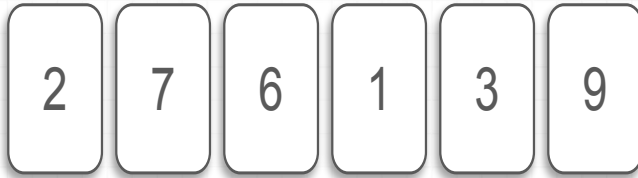
When should this be behind the scenes vs visible to player?  
Does the player notice or care that the distribution of 50/50 events is too balanced?

Essentially what we're doing is it making the Gambler's Fallacy come true - the flawed reasoning that if you shake a dice a dozen times and you haven't gotten a 6 yet, you're due for a 6. That becomes actual valid thinking.

To answer, the question, I think it's mostly a matter of how it's communicated. "50% chance" implies a die roll, whereas "happens 50% of the time" is more accurate.

Note these are also all things the player can't control - by contrast, when it comes to the attack modifier deck in Gloomhaven, it's important the player have access to all the data.

# Card Probability Math



~~10~~  
cards  
remaining

$$\frac{1}{\cancel{10}} = \cancel{12.5}\%$$

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



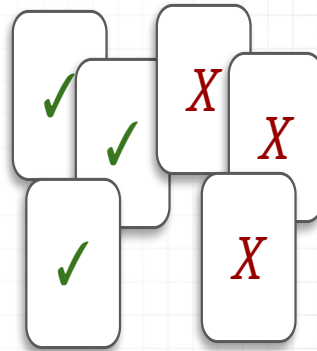
Here's how probability math works when it comes to drawing cards. Let's say it's a deck of 10 cards numbered 1-10 and you want to draw the ten. On your first draw, the odds are 1 in 10. If you don't draw it, then on your next draw it's 1 in 9 because there are only 9 cards left in the deck. And then 1 in 8. After you've drawn 6 cards without finding the 10, odds are 1 in 4 that it's next card you draw.

So the denominator is how large the deck is, and we see it evolves as cards move from pile to another (here: draw pile to discard pile). The numerator is how many cards you're looking for: if you're looking for either the 10 or the 9, then the numerator would be 2 instead of 1.



# Deck Size

3 events



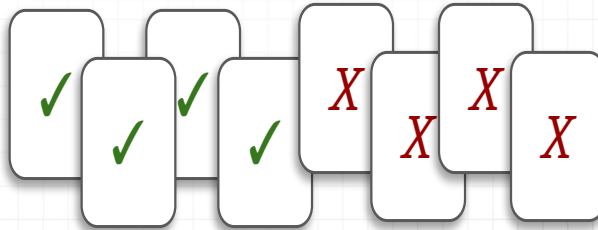
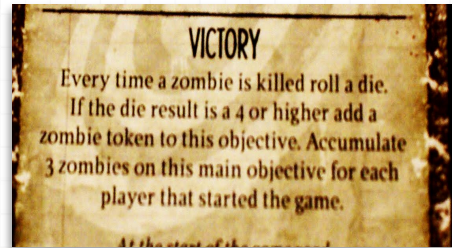
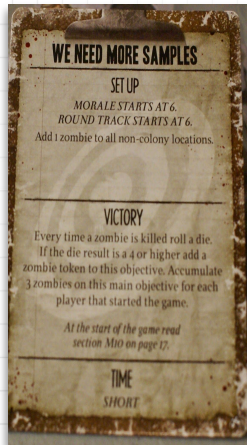
March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



In examples like this, the size of the deck really determines the pattern of events. Let's say we know the trigger event is going to happen 3 times. If our deck has just 4 cards in it, then we know there there will be 2 yeses and 1 no, or else 1 yes and 2 nos. And we know if there as a 4th event, the card drawn would be the one that makes them come out even. If our deck as 6 cards in it, it's possible to get all yeses or all nos. As the deck size grows, that chance increases.

# Deck Size



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



Here again is that example of the objective from Dead of Winter being random. The way it actually works is that each zombie killed gives you a 50% chance of a victory point and you need (let's say) 10 points to win, so on average it takes 20 die rolls to earn enough victory points. The randomness I think is being used to create drama and defeat some planning. The variability is just an undesirable side-effect. Using a yes/no deck instead of a die roll would remove the variability.

But how big should the deck be? You might think 20: 10 yeses and 10 nos. However, a deck of 20 actually says it will take 20 times at MOST (which happens when the bottom card in the deck is a yes) and it can only go lower from there. So you would need to do some fancy probability math to determine deck size such that 20 is the average amount of zombie kills required. The math examines the question: on average when does the 10th yes card get drawn from the deck?, and it can also determine the upper bound: how many draws are required at most before you draw the 10th



yes card.

# Card Probability Math



looking for 1  
specific card  
in a deck of  
10

| Draw |           | Odds | Cumulative |
|------|-----------|------|------------|
| 1st  | 1/10      | 10%  | 10%        |
| 2nd  | 90% x 1/9 | 10%  | 20%        |
| 3rd  | 80% x 1/8 | 10%  | 30%        |
| 4th  | 70% x 1/7 | 10%  | 40%        |
| 5th  | 60% x 1/6 | 10%  | 50%        |



We won't get into the gory details, but you can calculate things like: on average how many draws does it take to find a single card in a deck of 10? What this chart shows us is that, as we intuitively know, the card you're looking for has an equal chance of being any of the 10 cards in the deck. So when you draw the 5th card, that's when you've hit the 50% likelihood that you've drawn the card you're looking for.



# Card Probability Math



looking for  
either of 2  
cards in a  
deck of 10

| Draw |           | Odds | Cumulative |
|------|-----------|------|------------|
| 1st  | 2/10      | 20%  | 20%        |
| 2nd  | 80% x 2/9 | 18%  | 38%        |
| 3rd  | 62% x 2/8 | 16%  | 53%        |
| ...  | ...       | ...  | ...        |
|      |           |      |            |



When you're looking for either of TWO cards, you're likely to have drawn one or the other or both of them by the 3rd draw.

# Player Draw Pile in *Arkham Horror LCG*



Odds that  
specific  
cards are in  
the bottom  
10 cards of a  
deck of 30  
cards



1 card = 33%

2 cards = 10%  
(if you need either card)

2 cards = 56%  
(if you need both cards)

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



You can apply this kind of math to examine important questions about your design. Let's say the player has one especially powerful card in their deck of 30 cards, but let's say that during a typical game you only tend to draw the top 20 cards of your deck. What are the odds that you'll never draw your best card because it's one of the bottom 10 cards that you never draw? That's easy = 1 in 3. Maybe too high.

What if there are TWO best cards and you just need one of them; what is the chance that we'll get unlucky and we won't draw either of them - that's 10%. Better than 1 in 3.

What if there are two best cards but due to their design you have to draw BOTH of them. Turns out there's a 56% chance that you won't get both of them in the top 20 cards. This is a pretty important observation - for example when the player needs to draw certain cards to build combos, the odds of drawing them both are much lower.



# Player Draw Pile in *Arkham Horror LCG*



Odds that  
specific  
cards are in  
the bottom  
10 cards of a  
deck of 30  
cards



= 33%

= 10%  
(either card)

= 56%  
(if you need both cards)

This particular game, *Arkham Horror* offers the player a lot of tools for managing randomness, one is various ways to search your deck for a particular card. Other powers let you do things like preview or rearrange the top cards of a deck, take cards out of a deck or move them to the bottom, reshuffle, etc..

# Weakness cards in *Arkham Horror LCG*



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

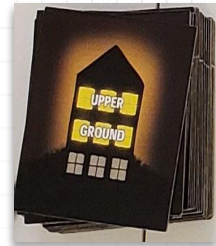
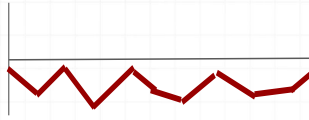


One way to think about draw piles of cards is that they have different values, you could argue it's the whole purpose to draw randomly from a deck of cards. Some cards are better, some are worse.

In Arkham you have a deck of player cards you draw from each turn to increase your power, but there are rare bad cards in this otherwise good deck. You can think of this in terms of expected value - normally you expect a positive card but occasionally you get a negative instead. Even if the negative isn't that extreme, it's a bumpy road for your game design to deal with - it adds more randomness. It's also subject to the same analysis we just finished such as: what if the chance the player will never draw it? Leads to swinginess between play sessions: this time I drew my weakness, this other time I didn't.



# Swinginess of Event Decks



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



There's less swinginess if you keep event decks consistent. All cards in the encounter deck in arkham are bad cards with a negative expected value.

However, even then it can vary depending on context - which character drew the card? Was it easy or hard for them to deal with? Which resource is being depleted and is that the crucial resource this play session? This is considered to be the biggest source of swinginess in this otherwise very well regarded game.

How can you deal with that? Well, it can be dangerous work: as you take steps to make cards count equally no matter which player draws it, no matter what the context is, which actions the group has taken previously, you're moving towards a place where the player's choices don't matter. In a video game, you can imagine some invisible intelligence that picks event cards depending on the context, to avoid exactly the wrong cards being drawn by exactly the wrong players. In a tabletop game, you can imagine the back of cards giving information about who should or should not draw it - Betrayal

At House On The Hill does something similar to build a random house that still fits together logically. This card here doesn't fit in the basement, so if you're supposed to draw a basement card you discard this one and try the card underneath it.

Or you can not have randomness at all: instead of an event deck, just a fixed thing that happens each turn. One very valid approach to randomness is not to have it: I learn as much from games by what they don't make random as what they do.



# Applicability of Cards



only valuable if you're  
at a locked door



only valuable if you have  
many resources



only valuable if you have  
a firearm item



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

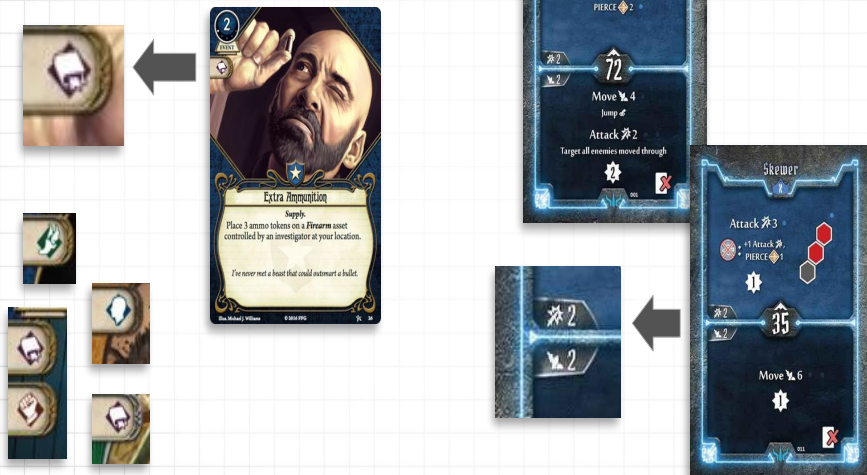


Another important thing about cards is that in some games they may not apply at the moment you acquire them. And then they might be taking up room in your hand until their condition comes to pass. The Lockpicks card has this problem - it's only valuable if you happen to have it at the moment you encounter a locked door. Expensive cards can be unplayable unless you happen to have a lot of resources. Combo cards don't work until both cards enter play.

Traits are one way to solve this - the Lockpicks work on all locks, not just locked doors. Or a card can benefit any weapon, not just any firearm. Traits can be used to increase or decrease applicability.

For combos, not having to actually have both cards in your hand at the same time - like you can store one somewhere until the other one shows up.

# Multi-Use Cards



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



And an even better way is to have multi-use cards, cards that have a secondary use that does something more generic but still useful. All Arkham cards can be (and often are) used to improve skill checks - it makes every card very useful even in cases where you can't play them for their main purpose.

Gloomhaven cards have secondary uses, not just that you can play any card for either its top or bottom use, but these generic secondary uses.

Secondary uses give the player a choice and therefore bounds the low end of the value of the card, it helps to normalize the value of cards in a stack. Choices also enable to player to craft more possible plans, build strategies, gives them more ways to improvise.



# Deckbuilders



*Honeymoon Whist*



*Slay The Spire*



*Magic The Gathering*



*Dominion*

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



The idea of deckbuilders is that it gamifies the responsibility of good deck design, making it a task for the player to solve: worrying about dilution from less valuable cards, narrow applicability vs broadness of cards, the chance of pulling off combos by having the right cards active at the right time.

And since that's now the player's job, the tools you give them are game design tools - the ability to add and remove cards from a deck, upgrade cards in their deck, etc.. If you give the player too much deck design power, the actual play with the deck might become too easy, too little power and it's frustrating, very similar to any other kind of game design.

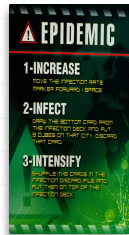
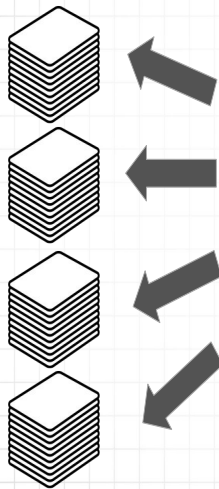
Which means your job as designer is one level up - determining the mechanics and parameters by which player have access to these game designer tools.

I think there's lots of space to innovate in the deckbuilder space; For example the standard design is that each problem the player solves with their deck is very similar (think: combats in Slay The Spire) and it's very difficult to customize your deck to solve those problems. In my own

game design, I make it very easy for players to create a custom deck from their collection, with the tradeoff that they have specialized tasks to accomplish in-game, so they can make a deck customized for one thing at the risk of it being less useful for other tasks they might encounter along the way.

Deckbuilders might be trendy but they are not actually new - the earliest one I know about is Honeymoon Whist, from the late 1800s, it's a trick-taking deck-building game played with a standard deck of playing cards.

# Manipulating Decks



Matt Leacock  
of *Pandemic*,  
*Pandemic*  
*Legacy*, etc.

I talked to Matt Leacock about how he designed Pandemic. In Pandemic the player draw pile of good things has a small number of very bad cards, the Epidemic cards. These cards cause the pandemic to move along its trajectory: Matt describes the game as a race between two positive feedback loops - the pandemic growing in destructive power as the players get increasingly better able to solve it.

These Epidemic cards are not simply shuffled into the player draw pile. Instead the draw pile is split into chunks of equal size and one Epidemic card is shuffled into each chunk. Stacking decks like this is trivial to do in digital, but Matt almost didn't include this in the tabletop game because it adds so much setup time. He went with it for game balance reasons - if cards were just randomly anywhere in the deck, it would be possible for too many epidemic cards to show up at the very beginning or end, which could make the game too flat, or tip game balance.

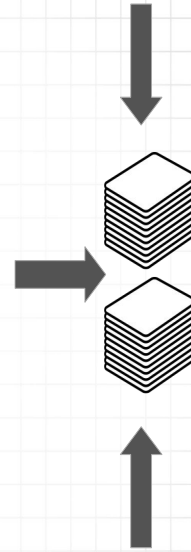
And it also adds a ton of positives. The pandemic grows in power at a steady rate but still unpredictably. Matt was able



to add the intensify step to each of the Epidemic cards, which in his words “lights a fuse on a bomb” to increase tension, which he could only do because these cards are spaced out. In extreme cases it’s still possible to draw 2 epidemic cards in a row, but in the case that that happens you necessarily benefitted from a quiet period before and you know there will be a quiet period after. This quality of “self-balancing randomness” is all over the place in Pandemic - a bad thing in one place automatically causes a good thing in another place.

# Manipulating Decks

- ♣ Insert card into specific portion of deck
- ♣ Insert card into deck after some event occurs
- ♣ Put multiple copies of card into deck and remove the dupes after the first is found
- ♣ etc.



There are lots of ways to stack and manipulate decks, and they are a great designer tool for managing randomness. These essentially control the probability of a card being drawn, or enforce some timing or staging of when the card will be drawn, while still maintaining some uncertainty and variability.

When it's done in tabletop games it's evident to the players so it informs their strategy. In digital you can make it invisible to players.

# Self-Regulating Randomness in *Pandemic*



March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally

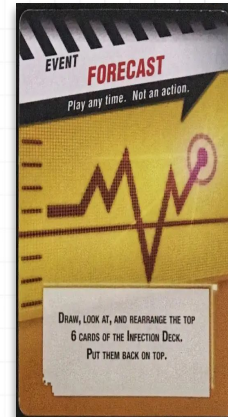


I really admire *Pandemic*'s design - it's gorgeous and elegant, especially that quality where the randomness seems to regulate itself, where a bad thing randomly happening in one place is automatically complemented by a good thing happening somewhere else in space or time. As another example, it's bad for outbreaks if all your problem child cities are right next to each other, but that's balanced by the fact that it's easy to move between those cities to treat them. As another example, a bad random setup would be that the blue disease is your big problem child, but little do you know all the blue cards you need to cure it are at the bottom of the player deck. The auto balancing happens in two places: one that the other diseases will be easier to cure in part because stray blue cards won't be clogging up your hand, two that when you get the end of the player deck, the blue disease will be much easier to cure.



## Matt Leacock on *Pandemic*

- ♣ Cards instead of dice - “dice have no memory”
- ♣ Stacked decks
- ♣ Multi-use cards
- ♣ Input randomness
- ♣ Player tools to manage randomness →
- ♣ Playtest, iteration, observation
- ♣ Not tons of mechanics nor randomness



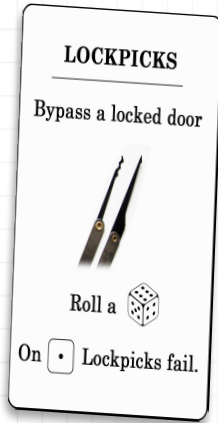
I interviewed Matt to ask about this and there is no silver bullet, no “Game Designers Hate This One Trick” (Matt’s joke not mine). But when he did share was reinforcing to what we’ve covered in this talk. Matt uses cards instead of dice because as he said “dice have no memory”. Pandemic uses stacked decks, and multi-use cards. It only has input randomness, no output randomness. There are player tools to manage randomness, such as this Event card which lets you rearrange the deck.

On top of those things, Matt does a ton of playtest observation and iteration, (but he does very little formal probability math). And the state space of Pandemic isn’t crazy huge with tons of moving parts, it’s pretty manageable. And like we said you can learn a lot from a good game design by noticing what it NOT random as much as what IS.

Subjectively, when there’s a ton of randomness in a game design, it sometimes feels loosey goosey to me, like a car where none of the bolts are tightened. But when a game has a small amount of well-chosen randomness, it you get that

tight, well-oiled machine vibe, and I think the self-regulating qualities come in part from that.

# Pitfalls to Be Wary Of



- ♣ Isolated/inconsistent random events
- ♣ One die (has maximum swinginess)
- ♣ Swingy events with large importance
- ♣ Cards with narrow applicability
- ♣ Decks with both positive and negative value cards
- ♣ 1 in 6 (may mislead psychologically)

This is the end of the talk! Here is our list of some of the ways that randomness can go wrong, many of which are represented by the Lockpicks card.

Be wary of random events that don't happen with any consistency, and which are disconnected from other game mechanics.

Be careful when you're just rolling 1 die without any aggregation or modifications.

Check on the weight and importance of random events, look for the weakest link.

Cards that have narrow applicability will sometimes, randomly be lower in value and may just take up space.

Decks that have both positive and negative value cards can be harder to design for.

And my own belief that rolling a 1 on a d6 just happens to be a bit misleading.



# Uses for Randomness

- ♣ Drama (*celebration, frustration*)
- ♣ Variety
- ♣ Chaos, surprise
- ♣ Creates a planning horizon / foils planning
- ♣ Saves players from too much planning
- ♣ Fuels planning → Improvisation
- ♣ Tilts the playing field, dilutes player skill contribution



Probably the most important thing is to add randomness not just because games have randomness but to achieve specific goals, the things that randomness does well.

To create those moments of drama - the tense cycle of frustration and celebration.

To add variety. For chaos and surprise.

To make it impossible to plan too far out, to save the players from analysis paralysis and therefore manage the pacing of your game. To defeat the player's plans in order to fuel the cycle of planning and improvisation.

And to tilt the playing field to make individual player skill less important.

# Tools To Manage Randomness

- ♣ Don't use randomness at all, or use less of it
- ♣ Aggregate Randomness, Offsetting dice to avoid the number 1 (d6+4)
- ♣ Input vs Output Randomness
- ♣ Use cards instead of dice to control periodic events
- ♣ Player Choice, Multi-use cards
- ♣ Hierarchies of success/failure to monitor flow of randomness
- ♣ Manipulating die rolls: re-roll, add, subtract, transform, etc.
- ♣ Manipulating cards: search deck, rearrange cards, remove cards, etc.
- ♣ Traits to make cards more/less applicable
- ♣ Stacking decks / manipulating decks

March 20-24, 2023 | San Francisco, CA #GDC23

Randy Smith | Using Randomness Intentionally



And after randomness makes its contributions, as necessary I apply these tools to manage it, to keep it from spilling over into places I don't want.

(With apologies for the small font.)

Know when to say no - think about when not to use randomness at all.

Aggregate randomness with many events. Or offset the outcome of dice to avoid the number 1.

Be mindful of input vs output randomness, input randomness is better for planning.

When designing periodic behaviors that happen at random, consider using cards instead of dice.

Offer the player choices, such as multi-use cards.

Provide hierarchies of failure so players can monitor how they're doing and not be surprised by one bad roll.

Give players direct tools to manipulate dice and cards: re-roll, search their deck, etc..

Use traits as a way to broaden or shrink the applicability of cards

Stack and manipulate decks to get what you want, especially in the digital space.



## Thank You!

Randy Smith - geminiradio@gmail.com

### Uses For Randomness

- ♣ Drama (*celebration, frustration*)
- ♣ Variety
- ♣ Chaos, surprise
- ♣ Creates a planning horizon / foils planning
- ♣ Saves players from too much planning
- ♣ Fuels planning → Improvisation
- ♣ Tilts the playing field, dilutes player skill contribution

### Tools To Manage Randomness

- ♣ Don't use randomness at all, or use less of it
- ♣ Aggregate Randomness, Offsetting dice to avoid the number 1 (d6+4)
- ♣ Input vs Output Randomness
- ♣ Use cards instead of dice to control periodic events
- ♣ Player Choice, Multi-use cards
- ♣ Hierarchies of success/failure to monitor flow of randomness
- ♣ Manipulating die rolls: re-roll, add, subtract, transform, etc.
- ♣ Manipulating cards: search deck, rearrange cards, remove cards, etc.
- ♣ Traits to make cards more/less applicable
- ♣ Stacking decks / manipulating decks

### Pitfalls to Be Wary Of

- ♣ Isolated/inconsistent random events
- ♣ One die (has maximum swinginess)
- ♣ Swingy events with large importance
- ♣ Cards with narrow applicability
- ♣ Decks with both positive and negative value cards
- ♣ 1 in 6 (may mislead psychologically)



one slide to rule them all