

# Prototyping Resilience: Using Games to Engage Communities in Disaster Response

Thomas Maiorana

*Assistant Professor, Department of Design*

University of California, Davis

# THE SACRAMENTO BEE

## 5 of the 6 largest California wildfires in history started in the past 6 weeks

BY MICHAEL MCGOUGH

SEPTEMBER 22, 2020 09:55 AM

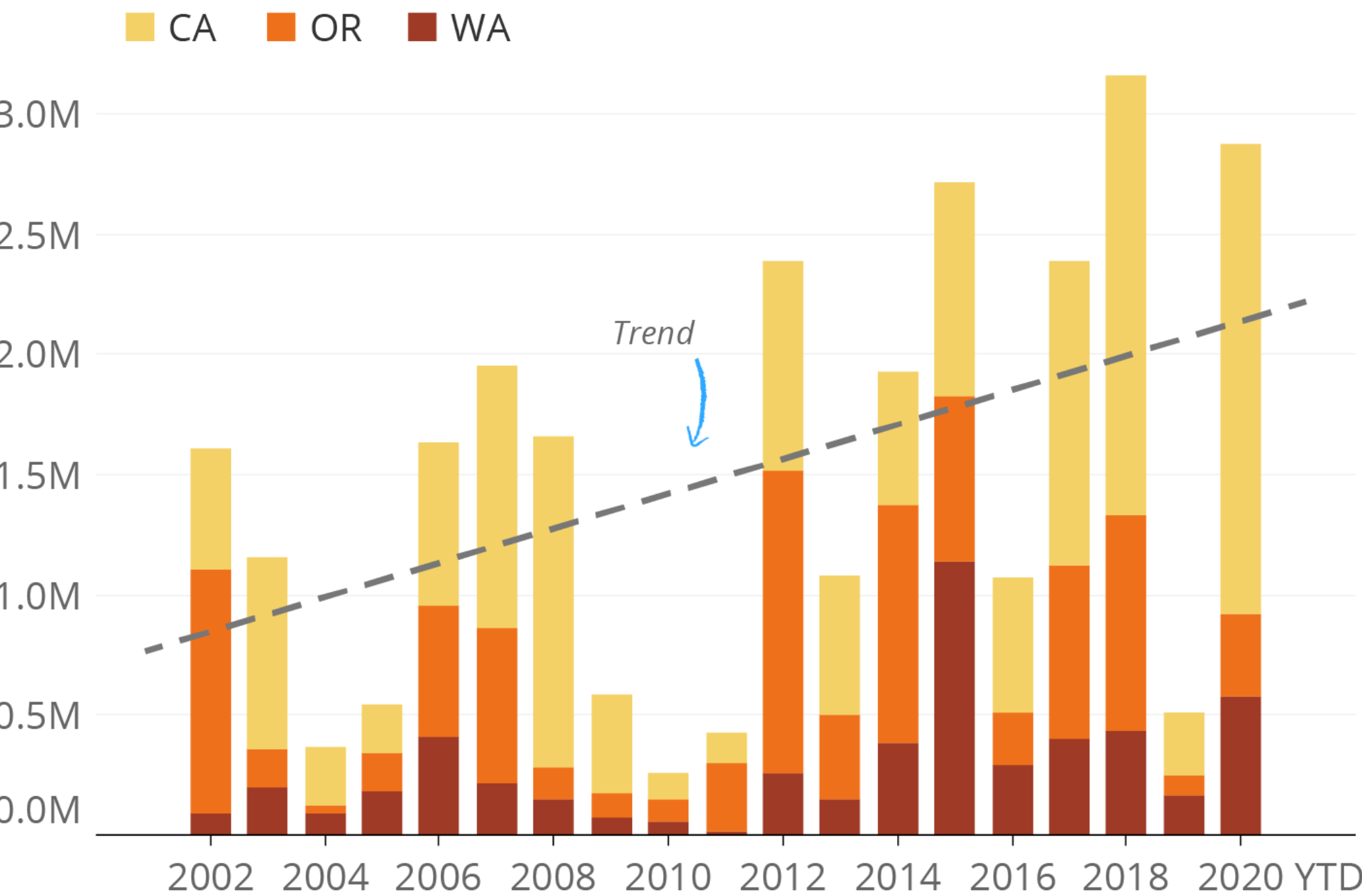


Many Creek Fire evacuees are still being kept away from their homes, not knowing if they are still standing or not. But fire officials say they are working hard to remove dangerous trees and improve road conditions so residents can return soon. BY [CRAIG KOHLRUSS](#)

The staggering statistics keep piling up for California’s wildfire season: August and September account for five of the six biggest fires in nearly 90 years of recorded history for the state.

## Life on Mars

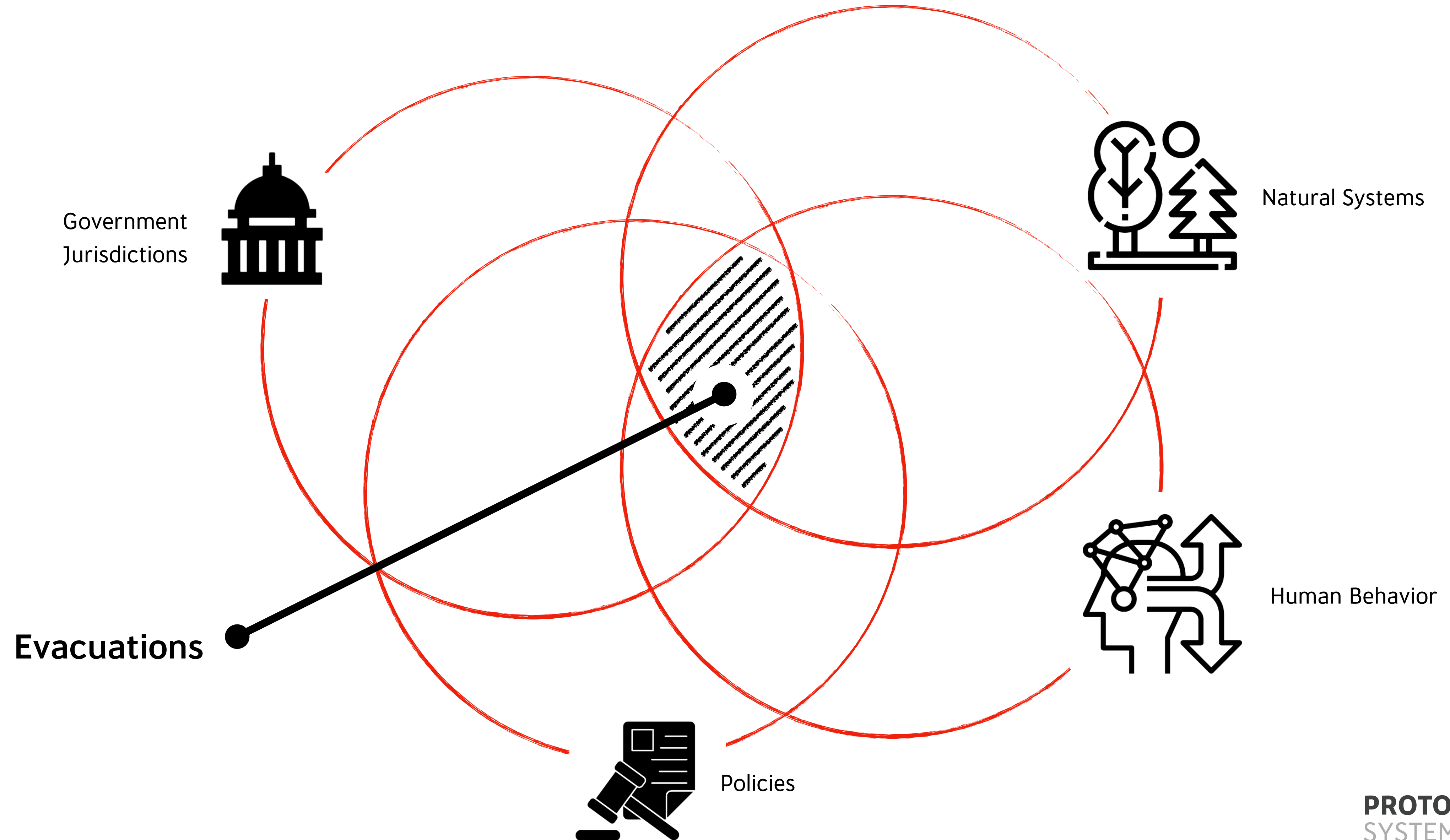
U.S. Western wildland acres burned, millions



Source: National Interagency Fire Center  
2020 data are current through September 9, 2020.



# Evacuation Event as a System





## **Systems** *(designer's perspective)*

---

*The design constraints are in flux<sup>1</sup>*

*The range of issues and influences will change with each prototyping iteration<sup>2</sup>*

*We are under intense time pressure<sup>3</sup>*

*The problem spans mediums, constituencies and disciplines<sup>4</sup>*

*There are many stakeholders and each have different perspectives and ideas of what is “right”<sup>5</sup>*

*Meaningful solutions require action from distributed groups<sup>6</sup>*

## **Wildfire Evacuations** *(community member's perspective)*

---

*Fire intensity, direction and size change constantly and influence routes and safety*

*An evacuee's actions will have an impact on others and the overall system*

*Minutes may make the difference between life and death*

*Evacuations require a range of skills and competencies. There's no single way to do it right.*

*An evacuation is a community event, yet motivations are deeply varied*

*Safe evacuations require effective collaboration across emergency personnel, government agencies, citizen groups and formal and informal networks*

---

*(1) Senge 2006; Meadows 2008; Ricigliano 2012 (2)Kurtz, Snowden, 2003 (3) Levin et al. 2012; Rittel and Webber 1973  
(4) Manzini 2015 (5)Rittel and Webber 1973; Buchanan 2019; Body, Terrey 2019 (6) Manzini 2019*



*prototype*  
*How might we ~~practice~~*  
*systemic change?*

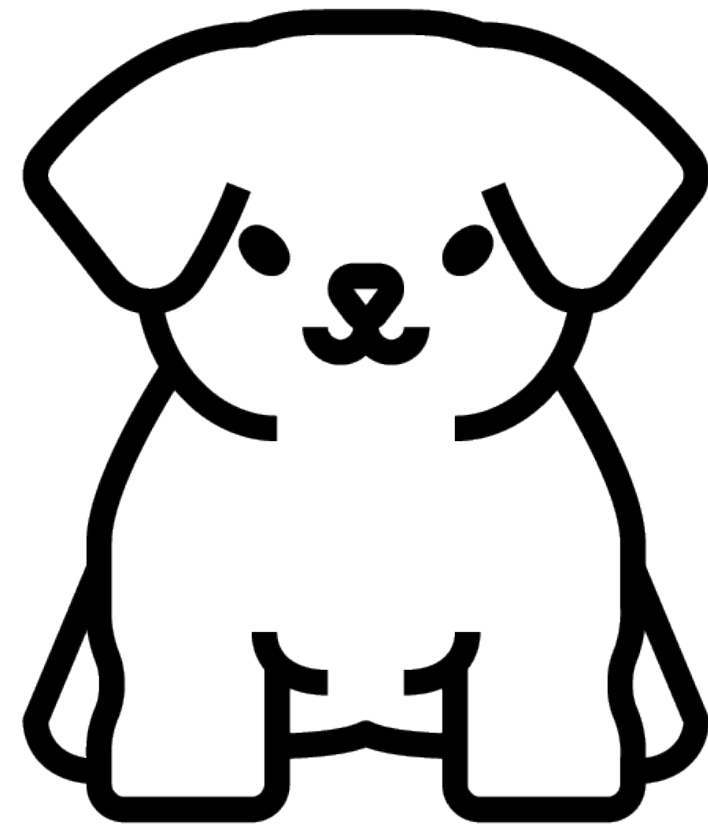
## **prototype** (n.)

*an intervention which **enhances** our ability to learn about an element of a design challenge with minimal risk, investment, and time.<sup>7</sup>*

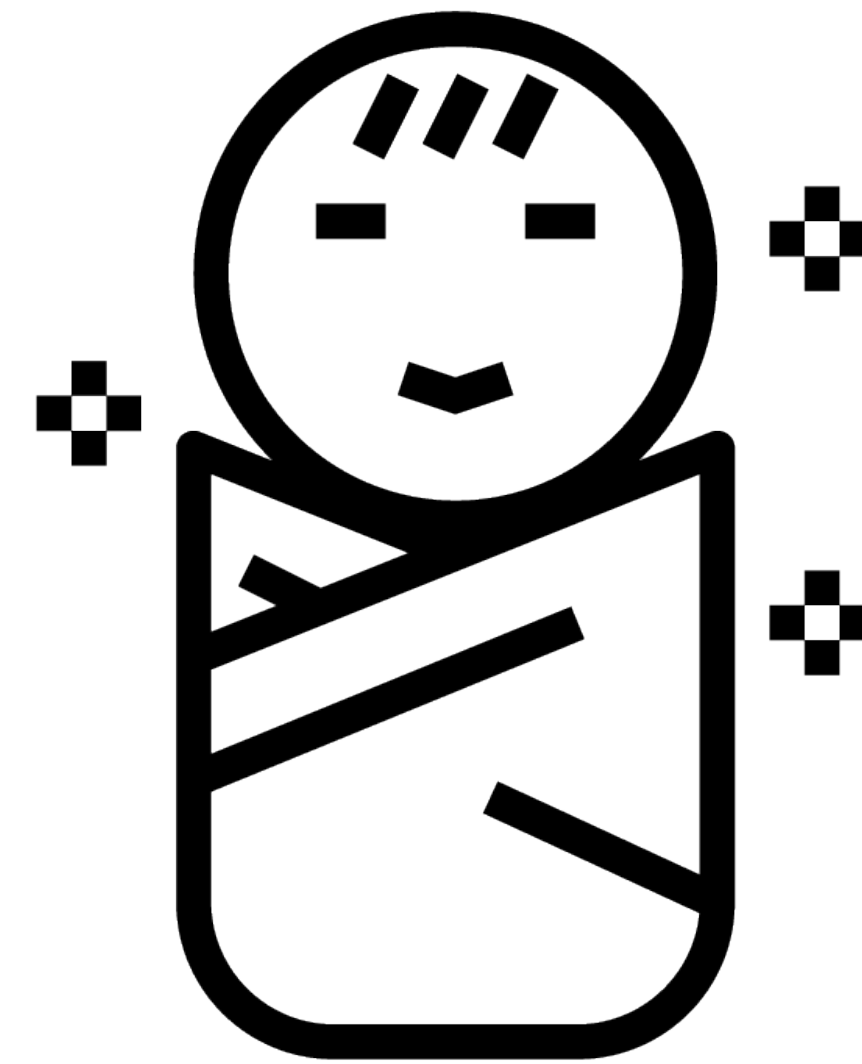
---

(7) Maiorana 2020; *The Failures of Prototyping, A call for a new definition*. Manuscript submitted for publication.

# Prototyping: Analogous Example



A low(er) risk way to learn



Major life choice with significant risks



A serious game is a game in which *education*  
(in its various forms) *is the primary goal*,  
rather than entertainment.

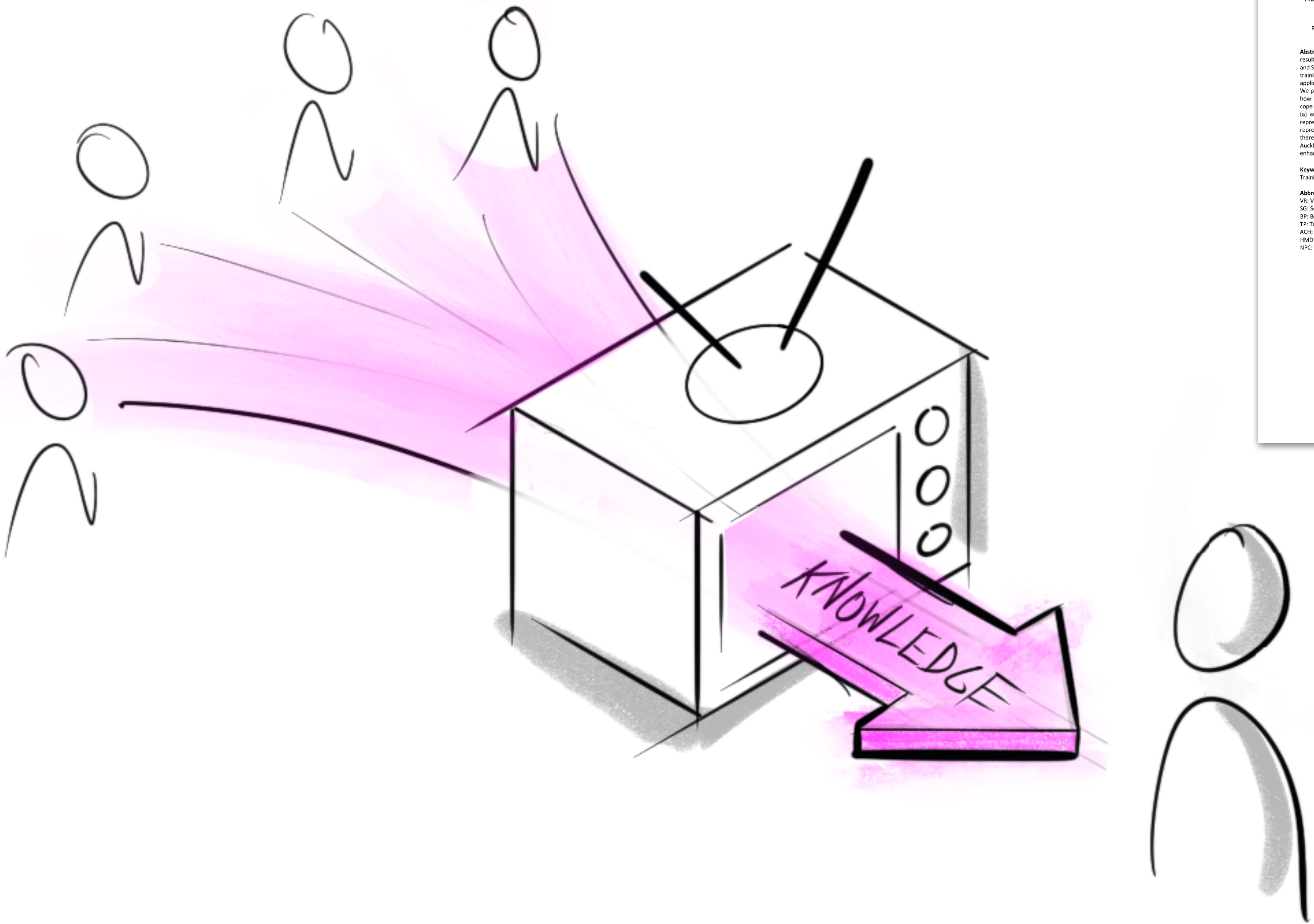
– *David Michael and Sande Chen, Serious Games, 2006*

“...playing a game is fundamentally  
a learning experience.”

*– Jesper Juul, Half-Real, 2005*

# Serious Game

Prototyping Virtual Reality: Serious Games for Building Earthquake Preparedness: The Auckland City Hospital Case Study  
*Lovreglio, et al, 2018*



Prototyping Virtual Reality Serious Games for Building Earthquake Preparedness: The Auckland City Hospital Case Study	
Ruggiero Lovreglio, Vicente Gonzalez, Zhenan Feng, Robert Amor, Michael Spearpoint, Jared Thomas, Margaret Trotter, Rafael Sacks	
<b>Abstract:</b> Enhancing evacuate safety is a key factor in reducing the number of injuries and deaths that result from earthquakes. One way this can be achieved is by training occupants. Virtual Reality (VR) and Serious Games (SGs) represent novel techniques that may overcome the limitations of traditional training approaches. VR and SGs have been examined in the fire emergency context; however, their application to earthquake preparedness has not yet been extensively examined. We provide a theoretical discussion of the advantages and limitations of using VR SGs to investigate how building occupants behave during earthquake evacuations and to train building occupants to cope with such emergencies. We explore key design components for developing a VR SG framework: (a) what features constitute an earthquake event; (b) which building types can be selected and represented within the VR environment; (c) how damage to the building can be determined and represented; (d) how non-player characters (NPC) can be designed; and (e) what level of interaction there can be between NPC and the human participants. We illustrate the above by presenting the Auckland City Hospital, New Zealand as a case study, and propose a possible VR SG training tool to enhance earthquake preparedness in public buildings.	
<b>Keywords:</b> Serious Game, Virtual Reality, Earthquake Evacuation, Human Behaviour, Occupant Training	
<b>Abbreviations:</b> VR: Virtual Reality SG: Serious Game BP: Behavioural Prototype TP: Training Prototype ACH: Auckland City Hospital HMD: Head Mounted Display NPC: Non-player Character	

Table 1 – Behavioural questions leading the BP design	
Earthquake Phase	Recommended Behaviour
Do participants drop, cover and hold (DCH) as the first action?	Yes
Do they have alternative behaviours as the first action? If yes which ones?	NA
How long did s/he take to decide to DCH from the start of the earthquake?	NA
<b>Pre-evacuation Phase</b>	
How long do they take to get out from under the table (if under)?	NA
Do they check for damage?	Yes
Do they unplug broken electronic device?	Yes
Do they use the phone to call someone?	No
Do they use the phone to text someone or to browse for information?	Yes
Do they assist other people?	Yes
Do they use the radio to collect information?	Yes
Do they take or use a first aid kit?	Yes
Do they use computers to browse for information?	Yes
Do they collect personal belongings?	Yes
Do they wait for instruction before starting evacuating?	Yes*
How long do they wait before exiting the room after the earthquake?	NA
<b>Indoor Evacuation Phase</b>	
Do they check the damage while evacuating?	Yes
Do they use the stairs or escalators?	Yes
Do they use lifts?	No
Do they check for injured people before going downstairs?	Yes
Do they check the damage of the stairs or escalator before using them?	Yes
<b>Outdoor Evacuation Phase</b>	
Do they stay close to the building?	No
Do they return inside the building?	No
Do they identify a safe earthquake assembly area?	Yes

\*for visitors

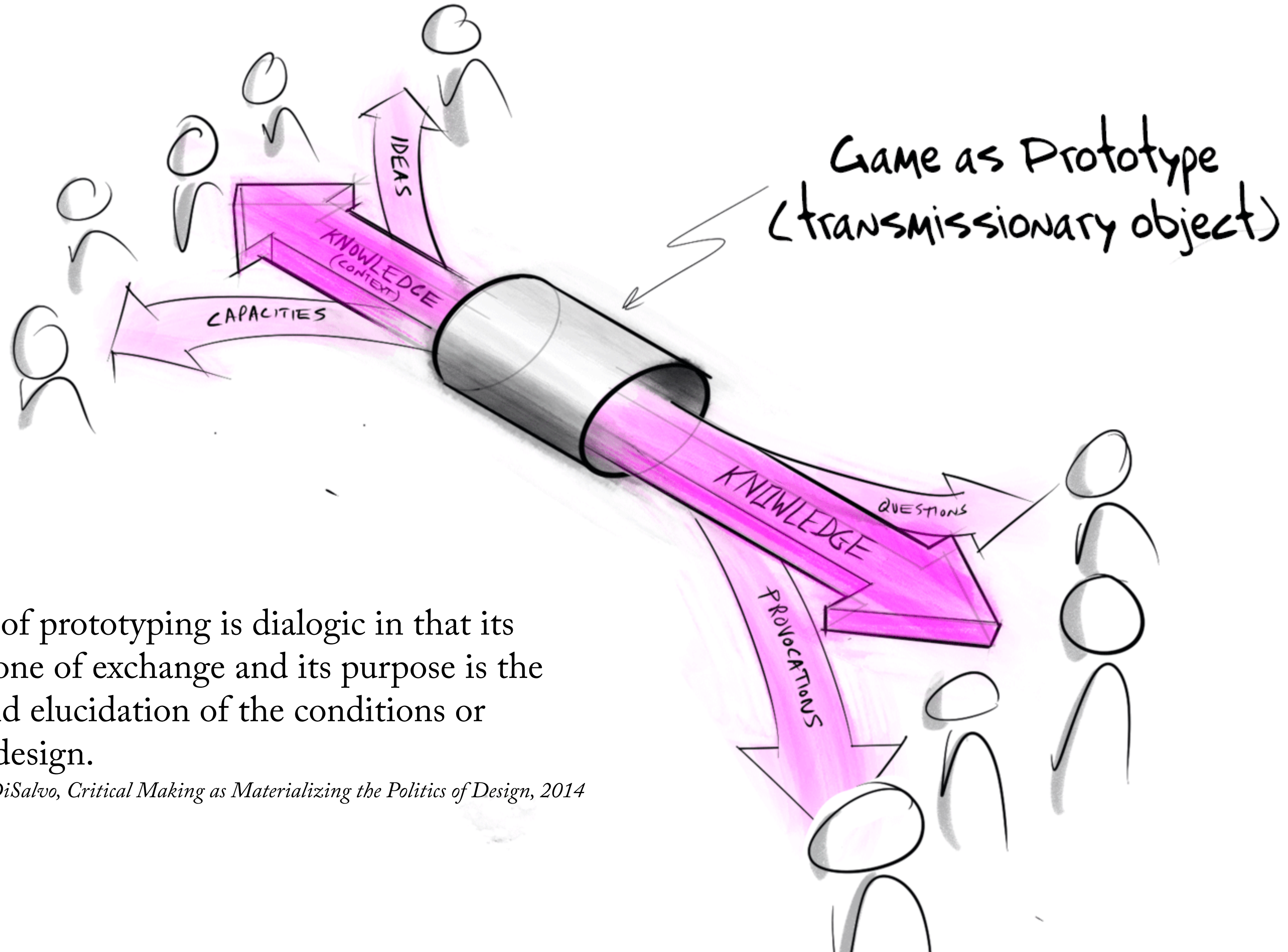
The TP was designed to generate training outcomes, i.e. enhance participants' knowledge on how to behave during and after an earthquake. Starting from the guidelines by New Zealand Civil Defence [2] and the ACH evacuation plan [38], we identify a list of recommended behaviours that needed to be taught through the TP as illustrated in Table 2. During the TP, participants were guided through several scenarios in which they needed to choose one or more of the recommended behaviours in Table 2 or alternative behaviours which are not in line with best practice.

The main goal driving the definition of the story lines for the BP and TP were the behavioural and training outcomes described in Table 1 and 2. However, the definition of these story lines needed to take into account all the constraints and possibilities related to the other components of the SG, such as the geometry of the virtual environment (see Section 4.1), the earthquake and damage simulations (see Section 4.2), the presence of NPCs (see Section 4.3) and the navigation solutions (see Section 4.4).

It was necessary to create a scenario in which participants could drop, cover and hold in a room during the earthquake phase and to perform all the potential actions described in the pre-evacuation phase included in Table 1. Finally, the evacuation path in the building and out of the buildings needed to



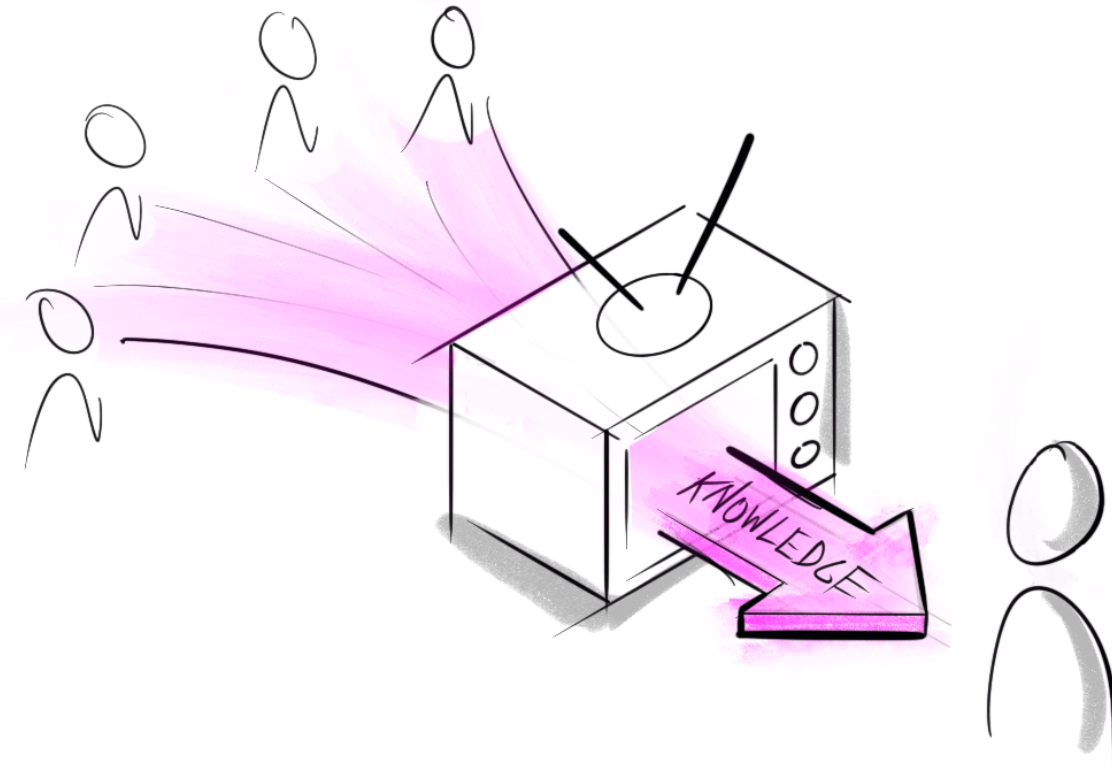
# Game as Prototype



The activity of prototyping is dialogic in that its structure is one of exchange and its purpose is the discovery and elucidation of the conditions or factors of a design.

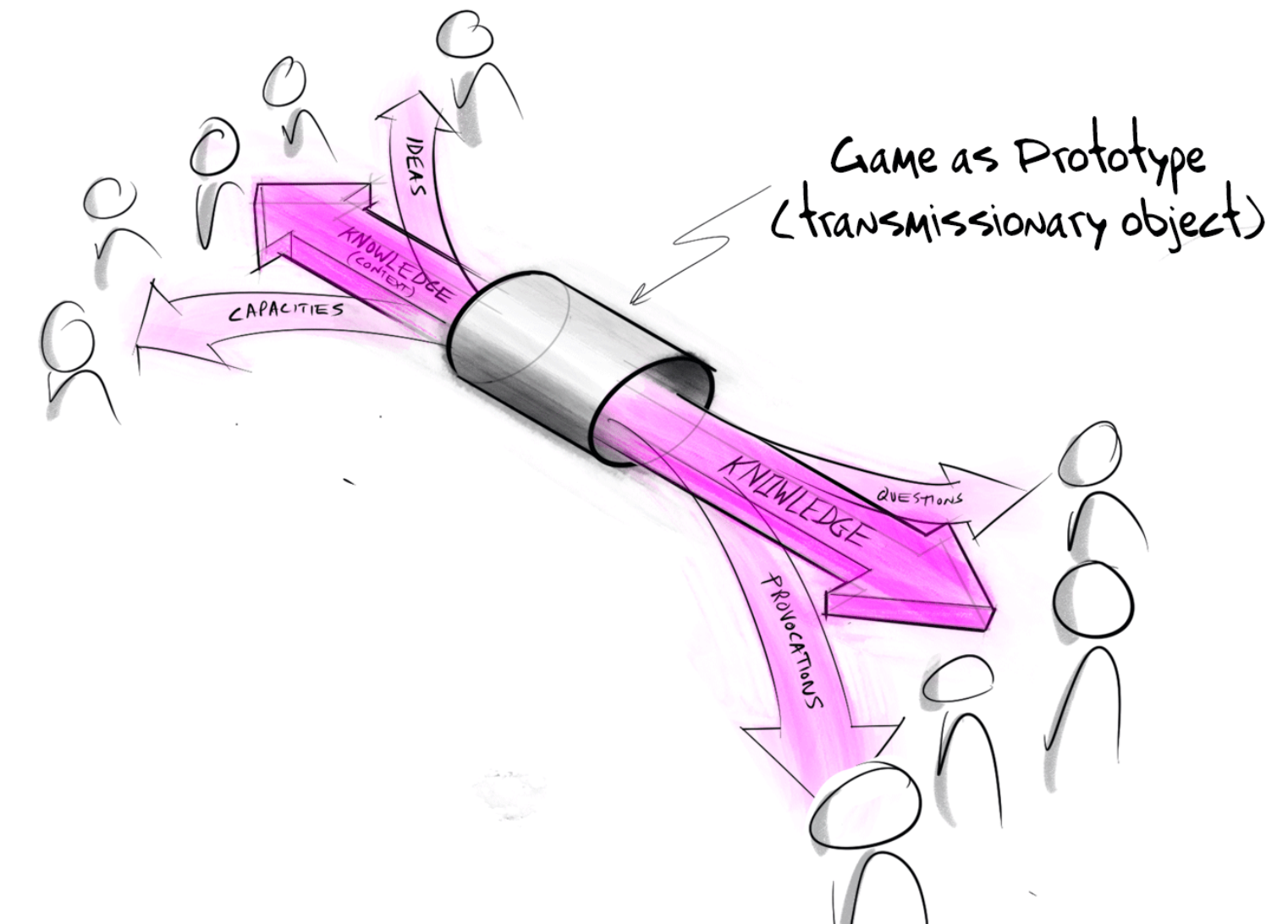
*-Carl DiSalvo, Critical Making as Materializing the Politics of Design, 2014*

# Serious Game



- Game designers in the role of “teacher”
- Knowledge is imparted through the game
- Success based on how much participants have learned

# Game as Prototype



- Prototypers construct environment that allows for **teaching and learning**
- Known elements are communicated through the game
- Provocations created to surface unknowns
- Success based on how much **participants and designers** have learned.



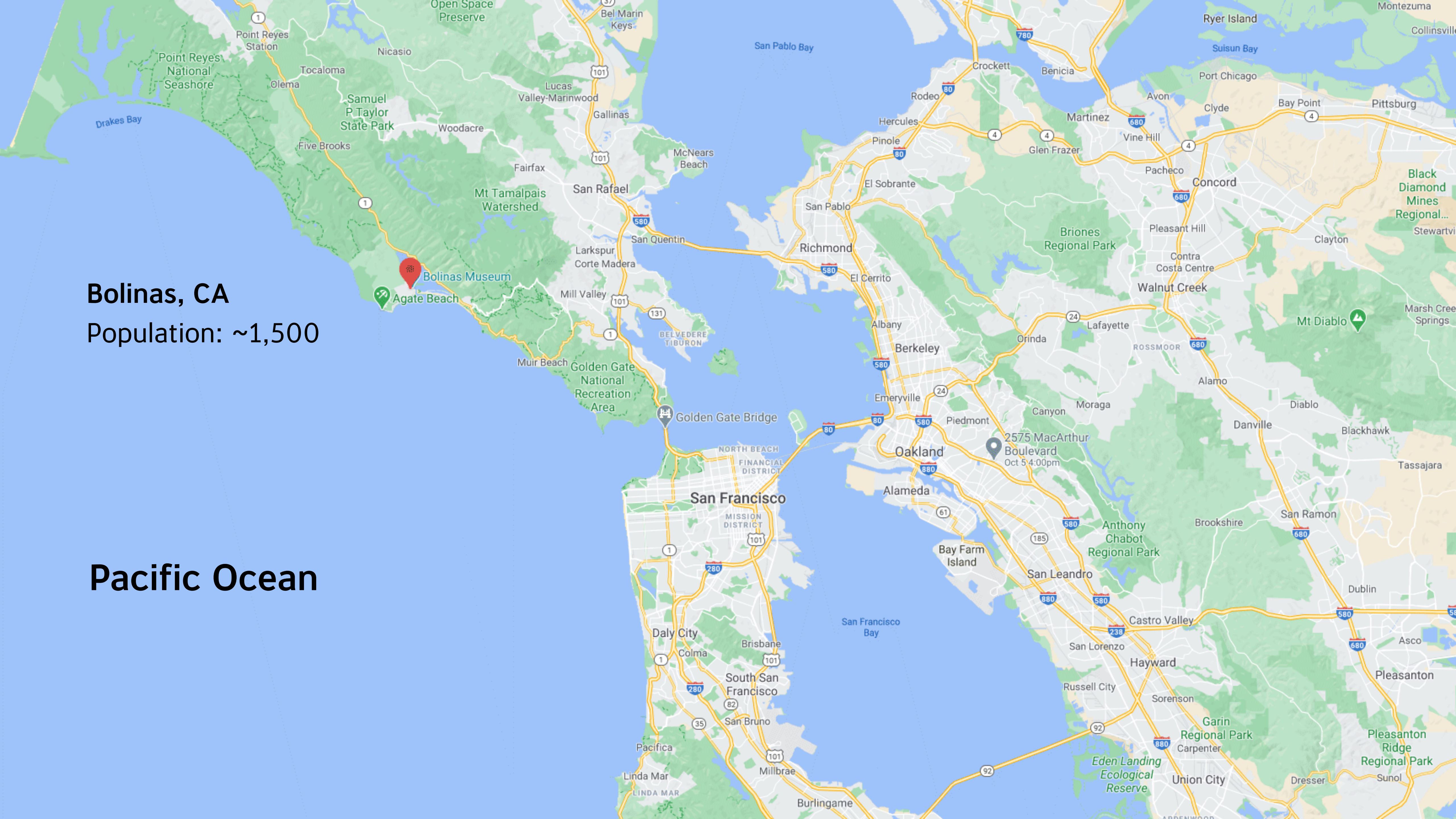
Approach	Time-frame	Cycles of Learning	Fidelity/Realism	Cost/Risk	Learning
Evacuation Policies and Procedures	Multi-year	1/year(s)	High	High	Uni-directional
Evacuation Drills	Yearly	1/year	Medium High	High	Bi-directional (potentially)
Educational Materials	Yearly	1/year	Low	Medium	Uni-directional
Evacuation Games	Monthly	1/month*	Low	Low	Bi-directional

\*this will be greater if more than one game is played per session



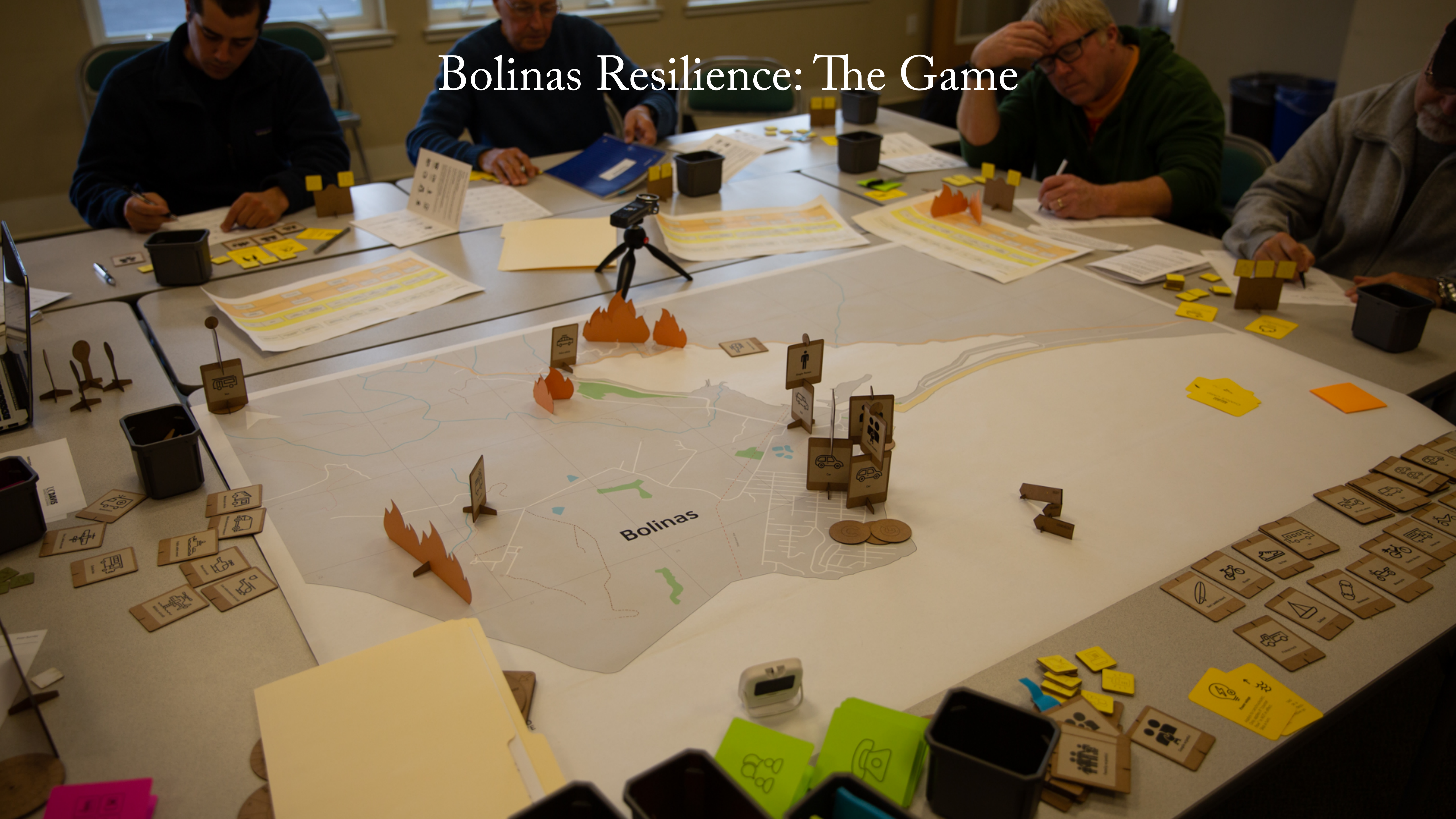
**Bolinas, CA**  
Population: ~1,500

**Pacific Ocean**





# Bolinas Resilience: The Game

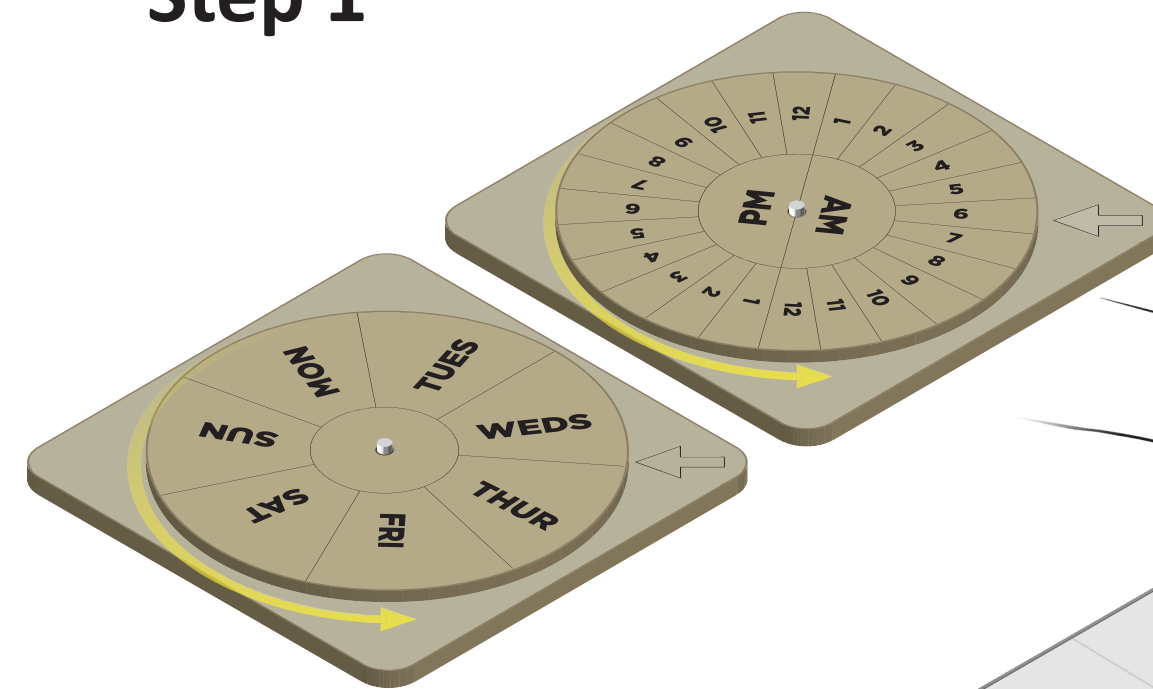




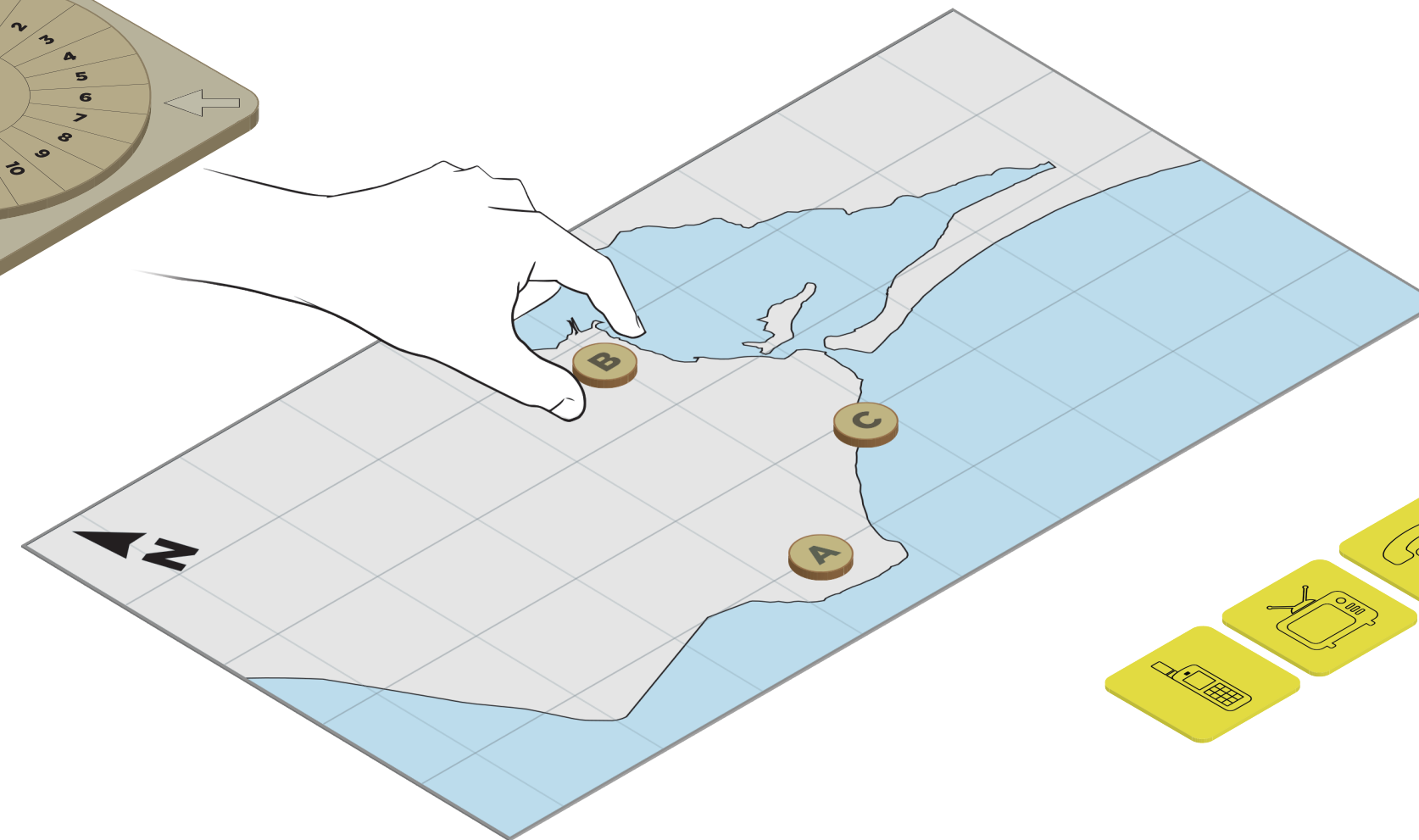
# Bolinas Resilience: The Game

## THE FIRE

### Step 1

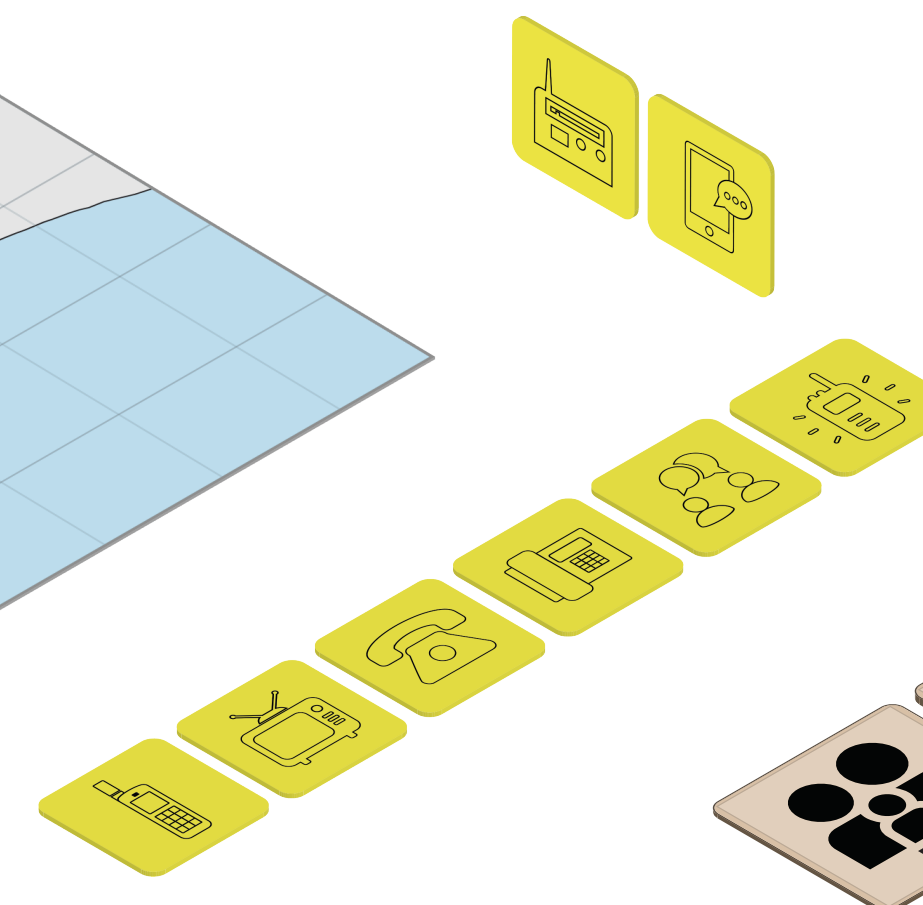


### Step 2

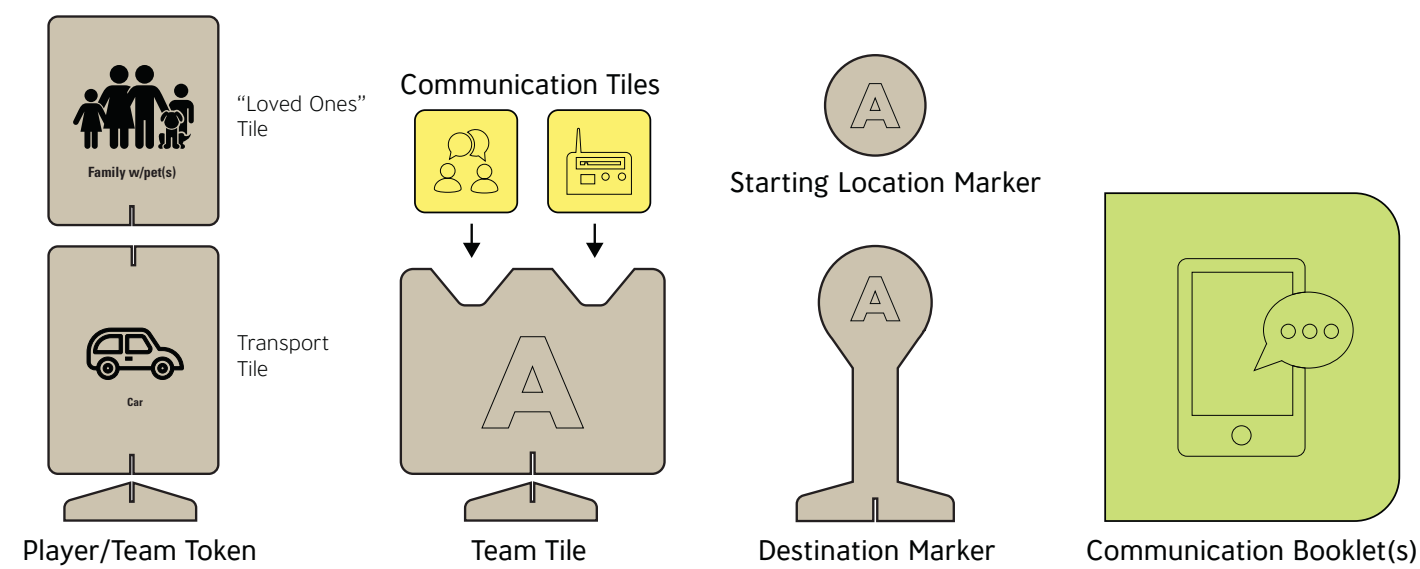
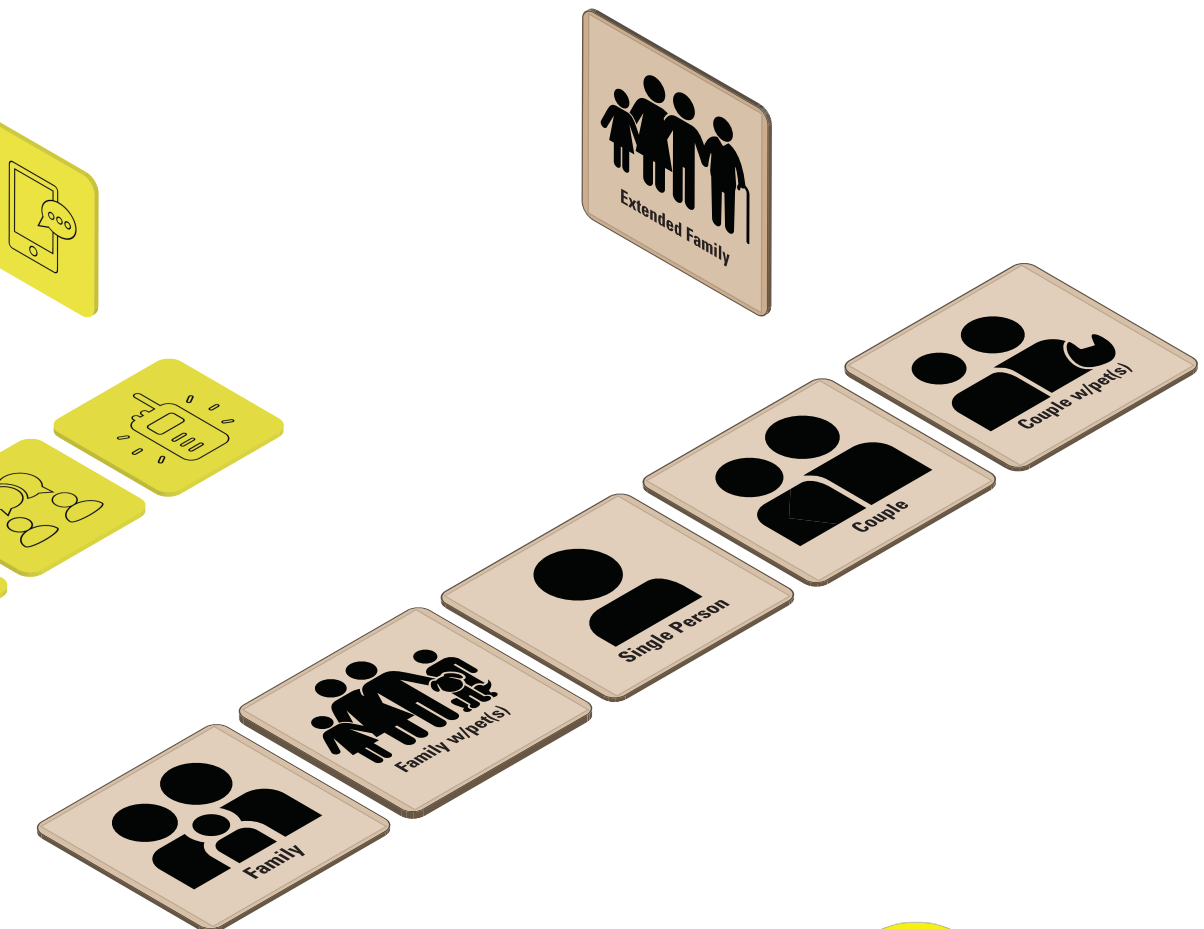


## COMMUNITY MEMBERS


### Step 3



### Step 4









**No gas**

Applies to any gas-powered vehicle. If your tank is less than full, skip a turn. (If you don't know how much gas you have, skip a turn.)




**Evacuation Plan**

If you have an evacuation plan for your family, move 2x as far for the next 2 turns.




**Regional Fire**

Another fire has started in the region and taking up outside firefighters' time. The "fire" will grow 1 extra size next round.



**Confused Surfer**


A confused surfer (doesn't seem local) stops you to ask what to do. You can help him out, but you'll lose a turn.




**Panicked Crash**

A panicked out-of-towner caused an accident. No one can move until the next round. (Disregard if anyone has decided to help a non-local.)

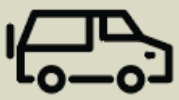
Educational




Car




Off-road vehicle




SUV



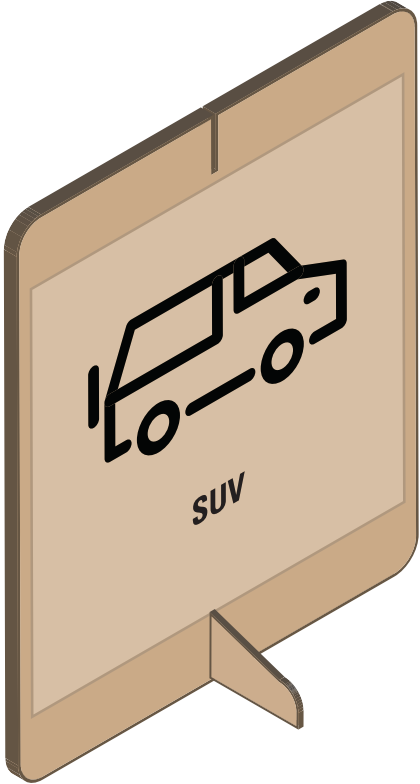
Van




Pickup truck




RV







On Foot




Mini scooter




Tractor




School bus




Multiple Cars/Vehicles




Jet ski




Electric skateboard



Motorcycle



Moped



ATV

Provocative



Bicycle



Electric bicycle



Electric scooter



Surf / paddle board



Kayak



Municipal vehicle



Heavy machinery



Sailboat

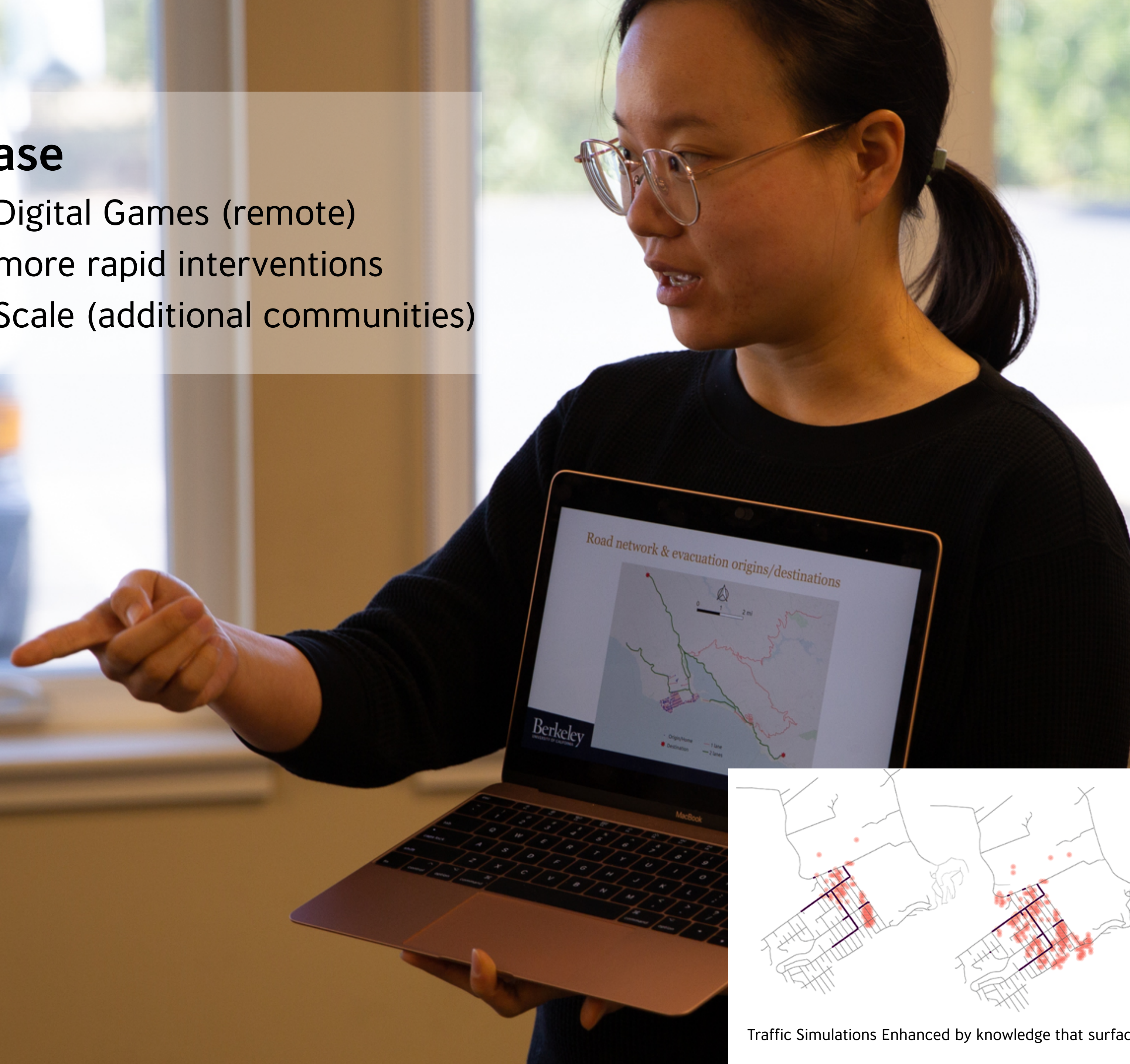






## Next Phase

- Exploring Digital Games (remote)
- Exploring more rapid interventions
- Exploring Scale (additional communities)



Traffic Simulations Enhanced by knowledge that surfaced during game play. (Bingyu Zhao and Kenichi Soga, UC Berkeley)



# Thank you!

 @ucdavistom

maiorana.faculty.ucdavis.edu

prototypingsystems.org