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# Prototyping Resilience

## Using Games to Engage Communities in Disaster Response

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### Abstract

This paper uses a wildfire evacuation preparedness initiative in the community of Bolinas, California as a way to illustrate how serious games can be used as prototypes for complex challenges. Wildfires are systemic events, and the speed, complexity, and scale of evacuations makes it very difficult to explore these types of scenarios in iterative and low-risk ways. The result is that policy makers are rarely able to test their policies and future evacuees do not have opportunities to experience how they might respond, communicate, and make decisions until they are in the midst of a life-threatening situation. The paper describes how a team of designers, civil engineers, and policy experts used games-as-prototypes to communicate best practices and explore the broader context of evacuations in Bolinas. The project demonstrates the ways the game *Bolinas Resilience* was used to translate the complexity and abstraction of systemic challenges into visceral, embodied experiences. The benefits of a game-as-prototype are discussed as well as the approaches that are required to design and evaluate this expanded form of prototyping.

**Keywords:** Prototyping, Systems, Resilience, Serious Games

### Introduction

The unprecedented proliferation of wildfires over the last several years have been a foreboding indicator of the ways that climate change is already impacting the daily lives of so many citizens across the globe. In the last year, wildfire activity exploded in Australia and California and even spread to previously safer areas like Siberia. In California alone, five of the six largest fires in the state's history started in the span of just six weeks (McGough, 2020). The speed, scale, and dynamic aspects of these disasters make them particularly difficult for the increasing number of communities that are situated in fire-prone areas known as the Wildland Urban Interface (WUI) (Radeloff et al, 2018). Wildfires are not going away. Their systemic nature make them highly challenging and beyond the reach of any single discipline or jurisdiction. The work detailed in this paper is that of design, but the thinking that informed it necessitated a collaboration between a variety of disciplines and constituencies.

Our interdisciplinary team's expertise spanned design, public policy, and civil engineering but we were aligned around a participatory design practice that recognized the critical role of community members in any effective solution. I led efforts related to design and was joined by Professor Kenichi Soga and Professor Louise Comfort. Professor Soga is a Civil Engineer and developed highly accurate traffic models that were used to inform and analyse evacuation plans and Dr. Comfort has studied community responses to disasters in situations ranging from fires to earthquakes. This research was supported by a 2019 Seed Fund Award from CITRIS and the Banatao Institute at the University of California with the goal of enabling better decision-making for the full range of actors during a wildfire evacuation. In order to explore this challenge in radically reduced time frames, our team approached the issue through the lenses of systems, prototyping, and games.

## Bolinas Background

Our team found a willing partner in the small unincorporated community of Bolinas, California. This idyllic village is nestled on the rugged Northern California coast to the northwest of San Francisco. On a clear day it is possible to see San Francisco from Bolinas, but it is anything but close. Bolinas is known for its isolation and is accessible only by miles of small winding roads that regularly bring in tourists for the hiking and surfing. The community has a population of about 1500 and this group ranges from artists, to wealthy second-home owners, to migrant workers and commuters and those who make a living related to the rich natural setting of western Marin County. The isolation that makes Bolinas such a special place is also one of its biggest vulnerabilities in terms of wildfires. It is situated at the WUI and has severely limited routes of escape. There is only one single road into to town and even with its modest population, this route could easily back up during certain fire scenarios.

Given the small population, Bolinas does not have a substantial Fire Department that one finds in the more sizeable communities to the east and south. Bolinas has just two full time firefighters and it utilizes volunteers and a “mutual aid” agreement with nearby towns to address the typical issues that emerge. The mutual aid agreement means that in the case of an event such as a house fire, nearby municipalities will send personnel and resources to support the firefighters in Bolinas. Unfortunately, in a regional event like a wildfire, the surrounding communities would most likely be fully occupied with the threats to their own communities and unable to offer support to Bolinas, making an effective evacuation that much more critical.

The mutual aid agreement is unique and complicating factor for Bolinas, but the regional nature of wildfires make interdependence a norm for these types of events. Evacuations cut across a range of jurisdictions and require coordination among several different divisions and levels of police, fire, and governments. It is a deeply systemic challenge.

## Evacuation Event as a System

Wildfires are emblematic of the challenges of addressing issues at a systemic level. Effective responses to these events necessitate input and action from varied government jurisdictions and community members in a way that is influenced by policy, human behaviour, and natural systems. Seen in this way, an evacuation event is a system. It requires a complex set of activities to be carried out by a diverse set of actors who often have competing sets of priorities.

**Figure 1. Parallels Between Systems and Wildfire Evacuations**

<b>Systems (A designer’s perspective)</b>	<b>Wildfire Evacuations (Community Member Perspective)</b>
The design constraints are in flux <sup>1</sup>	Fire intensity, direction and size change constantly and influence routes and safety
The range of issues and influences will change with each prototyping iteration <sup>2</sup>	An evacuee’s actions will have an impact on others and the overall system
We are under intense time pressure <sup>3</sup>	Minutes may make the difference between life and death

The problem spans mediums, constituencies and disciplines <sup>4</sup>	Evacuations require a range of skills and competencies. There's no single way to do it right.
There are many stakeholders, and each have different perspectives and ideas of what is "right" <sup>5</sup>	An evacuation is a community event, yet motivations are deeply varied
Meaningful solutions require action from distributed groups <sup>6</sup>	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

It is helpful to look at wildfires along with the ways we can view systems from the perspective of a designer. As noted in Figure 1, the very challenges we see in so many "wicked problems" also exist for wildfire evacuations. And while the scale of a wildfire evacuation is not quite as vast as global warming, it is a clear example of a way in which systems are nested within one another. One benefit of the reasonable scale of wildfires is that it allows us to see ways that design can play a role of influence in larger systems.

Yet the question remains, how might we create opportunities for community members to practice an evacuation? Put another way, how might we prototype systemic change? The nature of systems make it impossible to answer this question with a traditional approach to prototyping. In order to explore this arena, our team has utilized a definition of prototyping that is far more suited to systemic challenges. We use the definition of prototyping as "any intervention with enhances our ability to learn about an aspect of the design challenge with minimal risk, investment, and time" (Maiorana, 2021). This expanded notion of prototyping opens up possibilities for prototyping at the systemic level because it decouples the instantiation of the prototype from the learning it can yield, and it stresses learning over validation. To illustrate the point, I use the example of a couple thinking about having a child. They can get a dog as a prototype to learn more about the complex system of their relationship before fully committing to having a child. The dog can be considered a *non-linear* prototype. And while the dog is not an early iteration of a child, the learning it engenders is highly relevant to the challenge they face. Traditional prototyping focuses the learning on the thing itself. By creating non-linear prototypes, designers are freer to learn more about their idea and the context in which it may live.

### Approaches to Evacuation Preparedness

Within the realm of evacuations, many issues are already understood. Yet awareness does not always translate into safe or effective action. We only need to look back a few years to 2018 in Paradise, California. Even though Paradise had a robust evacuation plan, it was still the deadliest wildfire in California's history (Hay, 2018). It is clear that awareness is not enough. Our team was interested in closing the gap between knowledge and action for community members so that they might be able to be more prepared if the need to evacuate emerged.

But wildfires are infrequent events and there are few opportunities for community members to prepare in a low-stakes environment. Furthermore, there are few pathways to help government and emergency personnel develop plans that take the knowledge and experiences of the community into account. The existing approaches, whether evacuation policies, drills, or educational materials have few elements that can help officials learn from the experiences. As illustrated in Figure 2 most of these experiences offer community members the chance to learn just once a year and, in most cases, they will only allow the stakeholders to iterate their offerings once per year.

**Figure 2. Rates of Learning for Evacuation Preparedness Approaches**

Approach	Cycles of Learning	Fidelity/Realism	Cost	Learning
Evacuation Policies	1/years	High	High	Uni-directional
Evacuation Drills	1/year	Medium	High	Bi-directional (possibly)
Educational Materials	1/year	Low	Medium	Uni-directional
Evacuation Games	1/month	Low	Low	Bi-Directional

The game we created gave us the opportunity to increase the “cycles of learning” from once a year to once a month (Kelley and Kelley, 2013). Due to the extensive time and coordination, most evacuation drills only happen once a year. By creating a shorter time between idea and feedback, our goal was to make a stronger connection between the Fireboard who was developing the policies and the community members that would utilize them in a moment of crisis.

Games have been used for some time for military exercises, emergency preparedness space, more recently in the realm of public policy and climate change (Samčović, 2018; Lovreglio, et al, 2018; Kim, 2019). In *Half Real*, Jesper Juul draws the line between games and education, stating “...playing a game is fundamentally a learning experience” (Juul, 2005). While according to Juul, all games may be learning experiences, Michael and Chen make a distinction about intention, and define the category of serious games that are marked by their core purpose being that of education, rather entertainment alone (Michael and Chen, 2006).

Serious games have tremendous potential for education and much has been discussed about their use in topics ranging from elementary school mathematics to Virtual reality simulations for earthquake evacuations (Lovreglio, et al, 2018). These games impart knowledge to the player/learner in a way that makes the act of learning more engaging. All of this works well in situations where the challenge is well understood, and the context is relatively static. The game acts as a device that broadcasts the content in a more palatable way. But this approach breaks down in situations where the full set of facts are not known. In those instances, we need the more expansive approach of game-as-prototype.

### Serious Games vs Game-as-prototype

A *game-as-prototype* is an inversion of the more traditional notion of a prototyped game, which adheres to the conventional understanding of the practice where iteration and testing are used to enhance a product. A game-as-prototype on the other hand, uses the game in service of the learning that a prototype should bring forth. When we use a game as a prototype, the game goes beyond a tool for broadcast and becomes a transmissionary object. The prototype helps its creators share information *and* listen for the signals that emerge when it is situated in a context. In his work on critical making, Carl DiSalvo describes the role of a prototype in this way. “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” (DiSalvo, 2014). This approach to prototyping reflects a sense of humility and respect for the implications that an intervention may have on a community where it is deployed. By leveraging the game as a tool for bi-directional learning, prototypes can increase understanding so that the designers can be far more responsive to the overall system.

Developing a game-as-prototype is related, but distinct from the ways one would go about creating a serious game. The major difference between the two experiences is the relationship that each have to information. In a serious game, the information is assumed to be static and known. The challenge before the designer is how to transfer that knowledge and understanding to a new audience. However, in a systems context, challenges are not bounded so there is a need to both act and respond as a way of learning (Kurtz and Snowden, 2003). In this way a prototype that both communicates information and solicits new understandings is a far more effective way to navigate this dynamic terrain (Figure 3).

**Figure 3. Serious Games vs Game-as-prototype**

<b>Serious Game</b>	<b>Game-as-prototype</b>
Designers assume knowledge of best practices	Designers assume partial understanding (at best)
Optimized to teach	Optimized for teaching and learning
Knowledge is imparted through the game	Knowledge is imparted through the game
Success based on how much participants have learned	Success based on how much <b>participants and designers</b> have learned
Unknowns are discarded	Unknowns are encouraged (through provocations)

Given these distinctions, there is still the question of what this looks like in practice. In the following section, we describe the approaches we used to create the game-as-prototype with the community in Bolinas.

### Bolinas Resilience: The Game

*Bolinas Resilience* is a tabletop game that uses a 5' x 3' regional map with roads and geographical features as the playing surface. The size was determined by the number of possible players (up to ten) and its ability to be played in a variety of settings. The size was as large as we could make it while still allowing it to fit on the folding tables that are typically found in firehouses, churches, and other likely venues for the game. The overall goal of the game is for players to get from their starting point to a safe location during a wildfire event. The fire size and location are randomly generated, and a set of rules based on vehicle, routes and external factors dictate how many spaces a player can move each turn. The "fire" kicks off each round of play and these rounds represent 15 minutes of real time. During each turn, players select a *Chance Card* which can introduce complexities into the evacuation. A player "wins" by safely getting themselves and their loved ones to a safe location.

The map has a subtle overlay that indicates the "steps" that a player can take, and the steps correspond to the traffic capacity of a section of a road. We purposely did not include street names in order to simplify the playing surface and as a way to signal the experience as different from that of using a map. We ran two sessions of the game with our initial audience of collaborators during the fall of 2019 and early winter 2020.

There are three roles in the game: The Fire, Emergency Personnel and Community Members. The Fire is played by the facilitator and acts as a kind of umpire for the game. In order to get the most out of the game, the facilitator describes the ways that the game will be used for research and stresses that everyone in the game should be playing themselves. That is, they should respond as accurately as they can, rather than act as they think they should in order to win.

**Figure 4. An image of the gameboard during play**

### Designing a game-as-prototype

At the most basic level, the designer of a serious game will decide which elements to communicate, and then create a way to share that information in an engaging form of gameplay. Given the ways in which *Bolinas Resilience* was different from a more traditional serious game, we needed to approach the game development in a new way. In addition to the steps described above, when creating a game-as-prototype, designers will also need to define areas of exploration and then develop a way to tease those out during the course of the game.

Before serious game designers can utilize elements of narrative, rules, outcomes, and interactions to impart the knowledge to participants, they must decide on exactly what they plan to share. Our team utilized our understanding of wildfire evacuations and early meetings with the Bolinas Fire Department to decide on the types of information that would be most beneficial to potential evacuees. We then wove these elements into the game mechanics. As an example, players who had an evacuation plan were allowed to move towards safety while those without a plan were required to skip a turn. (Figure 5)

Incorporating best practices into the game mechanics is a relatively straightforward process because the team has a clear sense of the lessons we intended to reinforce. If we want players to know that it's good to have an evacuation plan, we reward them for that behavior. But what about situations where there was no right or wrong answer? For these types of scenarios, we needed to identify the areas where our knowledge was most lacking. This approach has far more in common with design research and ethnography than game design. In *Bolinas Resilience*, our team knew that the community members' local knowledge could unlock information about approaches or barriers that wouldn't be clear to

outsiders. We knew that routes, vehicles, communication, informal networks would have an outsized impact on the community’s ability to evacuate safely.

Having identified these themes, we then built elements into the game that would help create space for richer interactions around these topics to emerge. In one case, we included the option for users to select unconventional vehicles as a way to spark conversation and allow for playful conversational detours. By incorporating surfboards and electric bikes as possible modes of escape we were hoping to create conditions where organic discussions about transportation could emerge amongst the players.

**Figure 5. Educational and Provocative Elements**



The act of identifying knowns and unknowns would not have been possible without the collaborative effort of the Bolinas Community and our own team’s experience with evacuations and infrastructure. Together we were able to form a working model that was part research agenda, part communications campaign. The final piece was to bring all of this together in a cohesive, engaging experience.

Each of the above processes could be categorized as the *prototyping strategy*. They help define the purpose of the prototyping effort. But the policy and systems arenas are littered with unused and ineffective strategies. A prototype, even one with an expanded definition, must be realized. A strategist becomes a prototyper when she is able to translate a range of intentions, ideas and questions into a tangible experience that will support teaching and learning. This will often require some experience with traditional design skills. For *Bolinas Resilience*, I relied on my background in graphic and product design to create and refine many iterations of game pieces, cards, instruction sheets, maps, and game rules. We needed to make the game-as-prototype as fast as we could, but it needed to be resolved enough to make people want to play the game. When measured against other games, the version we presented could be considered medium resolution. However, when measured against a policy, it is decidedly low-resolution.

## Outcomes

Feedback is an essential part of any prototyping effort. When evaluating a game-as-prototype the team should focus on the communication of knowns, the provocations, and the game itself. Each of these discrete areas should be measured in a different way as illustrated by the questions in Figure 6. This kind of framework is essential for the more expanded notion of prototyping because, unlike a traditional evaluation that focuses on the object, this approach makes the examination of the context and explicit part of the feedback.

**Figure 6. Evaluating a Game-as-prototype**

Aspect of the prototype	Evaluation
Communication of Knowns ( <i>best practices</i> )	Are we seeing an increased understanding of best practices related to preparedness? Is this a more effective way to impart knowledge?
Provocations to explore context	What has the design team learned from the community?
The Game	Is there a more efficient way to learn about the above questions? Are there unexpected benefits or consequences to the playing of the game?

In January 2020, we held the second of two testing sessions with members of the Fire Department and the Bolinas Fire Protection District and we used these evaluation criteria to guide the ways we moved the project forward. While we had some community members as part of these sessions, the main purpose of those early meetings was to optimize the game for a larger rollout with the community. The initial groups were much more aware of the issues related to wildfire evacuations. Working with them was necessary and valuable as a way to understand their needs as community leaders, but it didn't give us insight into the mindset of community members who weren't as passionate about wildfire preparedness.

After this session, our plan was to create a few tweaks to the game that would help highlight the issues that were of most interest, and then host a larger community event in the spring. Then COVID hit. We were forced to scuttle the community event until later in the summer, giving us time to move the game into a digital format. Unfortunately, in August, an unusual lightning storm moved through northern California causing some of the largest wildfires on record. Bolinas on the edge of one of the fire complexes and our team decided to wait until the end of fire season before re-engaging with the community. It wasn't until November of 2020 that the team finally had the bandwidth to start working with our team.

## Initial Findings

After two rounds of play in a very limited context we know that the game itself is ready to use in community setting. Although we weren't able to play the game with the larger community, we were still able to glean some learning from the limited experiences with the game-as-prototype. We didn't play the game with enough community members to understand the efficacy of sharing best practices, but

the two rounds of game play helped us to flag potential elements of context that could prove useful for future policies. We also heard comments that foreshadow clues to the local knowledge that we are eager to explore in further testing. Offhanded comments like, “Well, I never come back into town without a full tank of gas” or “God help us if there’s a fire on weekend when there’s good surf” provide rich areas for future inquiry. The fact that these emerged in the spaces afforded by the game are an indicator for the potential of this mode of exploration.

As we look to future iterations, our team is also mindful of the unexpected ways that the system may be changed by the intervention. By gathering community members around a structured (and enjoyable) activity, might we also be creating opportunities for them to form new connections to each other? We know that community cohesion is critical for resilience (Aldridge and Meyer, 2015). Our initial hypothesis is that if we can create an excuse to learn from community leaders and each other, then they will be more likely to build the social connections that will be necessary during an evacuation event.

## Conclusion

Our work with the community of Bolinas continues. We’re in the midst of recreating the game in an online setting that will be shared in a virtual community wide workshop in late March 2021. We’re also expanding the ways we engage with the community and will be hosting a series of game building events with a class of 6<sup>th</sup> graders in Bolinas. As we move forward, we’re using the lessons learned from Bolinas to explore the ways in which a game-as-prototype can be used in vastly different settings. We’ve been approved for a CIVIC Innovation Grant from the National Science Foundation and will use that project to extend this way of working to fire-prone neighborhoods in Oakland, California.

Prototyping has tremendous potential to impact policy and systemic challenges. But for this to happen, we need to rethink the prototype as a missionary object. One way to do this is to build on the work of serious games and develop games-as-prototype as a way to explore a system context in a way that embodies a more expanded definition. The work in Bolinas demonstrates how we’ve built one such version of this type of intervention. The work is still in early stages but as we develop it further, we have high degree of confidence that this is a more flexible, nimble and expeditious way of exploring systemic challenges.

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